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THREE PHASE MOTOR AT BELLEGARDE.

At Bellegarde, twenty miles below Geneva, the power of the Rhone is utilized for driving many different plants, partly by means of ropes, but mainly by electrical transmission. The most interesting of the works driven electrically at Bellegrade is the cotton mill recently erected. This mill, which is 550 yards distant from the water power and generators, employs one three phase motor of 120 to 170 horse power for driving the openers, carding, combing and drawing frames and fliers, and supplies 360 incandescent lamps. One 120 to 170 horse power three phase motor drives the self-actors, and one 15 to 30 horse power motor of the same class is employed for driving the ventilating fans and the workshops.

These motors, which were constructed by Brown, Boveri & Company, Baden, are illustrated in the annexed engravings, which we take from Engineering. The larger motors weigh 5·8 tons each and the smaller motor weighs 1·2 tons. These motors are started by resistance starters, and under normal conditions attain their full speed in the space of one minute. The inducing part of the field of the motor which connects with the mains is outside, and stationary, while the armature or induced part is made rotary, thus avoiding sliding contacts. The winding of both parts is similar, the core being composed of alternating laminæ of sheet iron and insulating paper pressed together between two outer rings and pierced near the periphery by equidistant oval-shaped (or circular) holes in which the windings are placed. Portions of the inducing winding are so bent and arranged as to be always at the same distance from the axis of the motor, and in large motors (from 40 to 130 horse power) the straight portions are placed in stiff paper or ebonite insulating tubes fitting into the oval perforations.

The winding of the induced rotary part consists either of wire or of copper bars, and is also placed in peripheral holes. By this construction all the magnetic resistances in both parts are reduced to a minimum, while the peculiar winding of the inducing part insures perfect symmetry, great economy of space, and easy inspection and repair. The wires or bars of the rotary part extend beyond the core on each side, the ends being bent and soldered together to form a drum winding short circuited on itself. The windings of both parts are symmetrical, but independent of each other as regards polarity, the peripheral holes being equidistant and the surfaces of the alternating iron cores being smooth and uniform all around, and any number of poles can be formed in the inducing part without any polar projections. By virtue of this arrangement, the motor is enabled not only to run non-synchronously with the generator, but with a considerable torque without separate excitation, so that commutators and brushes are entirely dispensed with.

To start these motors it is necessary to produce a difference of phase to destroy the equilibrium of forces, which, although the current be switched on,

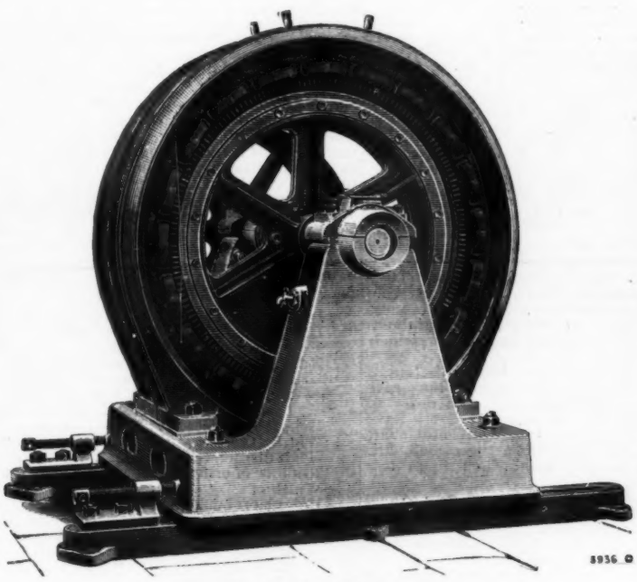


Fig. 2.—Side View.

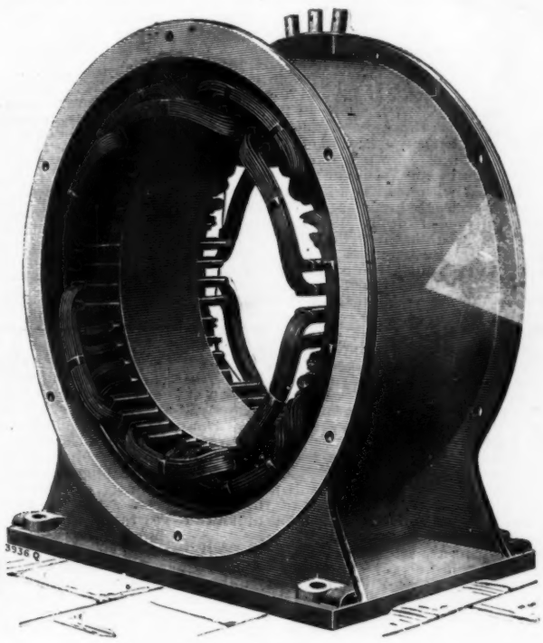


Fig. 3.—Field Magnet.

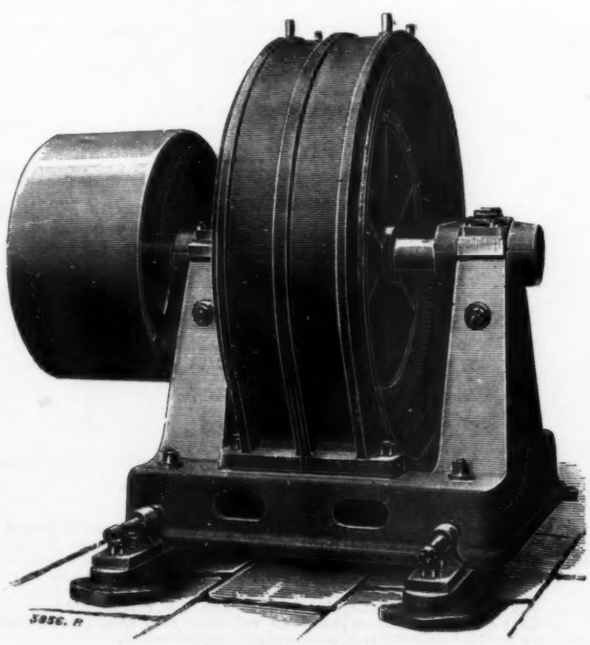


Fig. 1.—Front View.

Fig. 4.—Armature.

THREE PHASE MOTOR USED IN THE BELLEGARDE COTTON MILL ON THE RHONE.

causes the induced part to remain neutral, and prevents it from rotating unless it is set in motion. As differences of phase are produced by differences of self-induction, the desired object is brought about by adding to the ordinary winding of the motor a starting winding of small cross section having a different self-induction, so that when the two are placed in circuit with a generating alternator, a difference of phase and hence a rotary field is set up, which overcomes the neutral state and causes the armature to rotate.

The efficiency of these motors increases with the size and varies from 70 to 90 per cent. They are capable of developing 50 to 100 per cent. more than their normal power, and require no attendance beyond the renewal of oil once a week.

THE USE OF TURBINES WITH A HORIZONTAL SHAFT FOR RUNNING DYNAMOS.

IN recent years the applications of electricity have greatly extended, and this has very naturally led engineers to have recourse to the numerous waterfalls distributed over the face of the land for putting them to profit. In the first installations of this kind they confined themselves to the use of such motors as were then employed—waterwheels of all kinds, parallel turbines with vertical shaft, etc. These primitive apparatus, however, necessitated complicated arrangements, often cost considerable to keep them in repair, and were liable to give rise to serious accidents that sometimes occasioned a lengthy cessation of work. On another hand, it is well known that, contrary to what occurs with steam engines, the greater part of the expense connected with works run with water power resides in the cost of installation, the expense of maintenance and of running the machines being reduced to a minimum. It will be seen how advantageous it is from a technical as well as an economic view point to diminish the cost of installation as much as possible, while at the same time simplifying and improving the motors in such a way as to increase their performance.

It is to this end that have been directed the studies of hydraulic engineers, who have thus been led to the devising of special turbines designed more particularly for the running of dynamos. Among the numerous models of this kind we may mention the turbines with horizontal shaft which actuate dynamos directly without the intermedium of any transmission, and which were devised by the Brault, Teisset & Gillet establishment, founded by Mr. Fontaine, the inventor of the turbine that bears his name. These turbines are now very widely distributed, and we are going to describe a few types of them selected from among some of the more important installations.

The keying of the armature upon the same shaft, or upon a shaft forming a prolongation of that of the motor, is evidently one of the simplest and most rational of matters; but, unfortunately, such an arrangement is applicable only to falls of a height greater than 13 ft., since, below this figure, the velocity of the turbine is generally too feeble, especially when of a certain power.

On the contrary, with falls of from 25 to 40 ft. such an arrangement becomes very easy, and in this case the simplest application consists in employing (in placing it horizontally) the new American mixed centripetal turbine that we have already described in this journal. The turbine is installed in the same room with the dynamo, and then operates in an iron plate tank placed above the down stream level.

Figs. 1 and 2 show the installation of such a turbine. A frame of T iron, or, what is preferable, of cast iron, receives the tank, to one of the sides of which is fixed the discharge tube that enters the down stream water. The shaft of the turbine rests upon two self-lubricating bearings of considerable length, and, moreover, in order to prevent any loss of water in its exit from the tank, it passes through two stuffing boxes mounted upon the latter.

The opening and closing of the turbine is obtained very easily by means of a small handwheel carrying internally a fixed nut through which passes the threaded shaft that actuates the cut-off. This shaft likewise traverses a stuffing box at its exit from the tank. The jacket of the turbine in the interior of the tank is very strong, and a manhole gives access to the motor, so that it can be easily cleaned when necessity requires it.

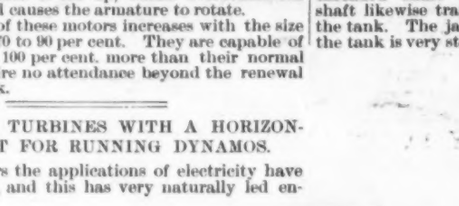


FIG. 1.—MIXED CENTRIPETAL TURBINE WITH HORIZONTAL SHAFT.

FIG. 2.—MIXED CENTRIPETAL TURBINE OF 45 H. P.

The following are the principal dimensions, etc., of the turbine represented in Fig. 2:

Motor	40 to 45 h. p.
Fall	42 ft.
Discharge	90 gallons
Velocity	630 revolutions
Diameter of delivery pipe	28 in.
Diameter of tank	3·5 ft.
Length of tank	4 "
Diameter of discharge pipe	20 in.
External diameter of distributer	30 "
Height of buckets	6 "
Diameter of turbine	13 "
Diameter of turbine shaft	2·4 "
Diameter of turbine shaft at bearings	2·4 "
Width of bearings	4 to 5·5 in.
Distance between bearings	8 ft.

The performance of these turbines varies between 80 and 87 per cent. of the total theoretical power. They are therefore excellent motors, which combine extreme simplicity with very great stability. Moreover, in most cases, in order to obtain a still better result, the dynamo and motor are mounted upon the same frame, which is cast in a single piece.

But, in the case of large falls and heavy discharges such turbines, since they are not balanced, may give rise to lateral thrusts upon the shaft. In order to remedy this inconvenience, the manufacturers have conceived the idea of keying two horizontal shaft turbines of opposite direction upon the same shaft. Fig. 3 represents a turbine established upon this principle.

This new type of turbine was devised a few years ago by the Brault, Teisset & Gillet establishment for application in a very special case. It was a question of running a sugar cane mill that had to be actuated by a reversible hydraulic motor that, when necessity required it, could be run backward in order to clear the mill when the cylinders became gorged and choked up by an excess of bagasse.

As this arrangement furnished good results, the manufacturers naturally thought of applying it to the direct running of dynamos. Fig. 3 represents a turbine of this kind designed to run the Bourganeuf works for transmitting electric power. The motor is established upon a solid cast iron frame which carries both the tank that holds the two turbines and the dynamos that they actuate. The tank is closed laterally by the two distributers of the turbines, which carry a central tubulure that permits of connecting them with each other by means of a cast iron tube that serves likewise as a cross brace, and thus permits of avoiding flexions due to pressure.

The orifices of these two distributers extend only over half of their circumference, and their opening and closing are regulated by means of bronze clack valves rendered absolutely tight through an ingenious arrangement of small grooves formed upon the surfaces in contact. The clacks of the two opposite distributers are connected with each other by means of steel rods and powerful springs which permit of balancing the pressure of the water in great part, and, consequently, require but a very feeble stress for their maneuvering. Moreover, they are very easily controlled by means of a handwheel mounted upon a shaft that carries pinions which engage with the rack that actuates them. This shaft alone is provided with a stuffing box.

The two turbines are of cast iron and hooped with steel. They are keyed outside of the tank upon the driving shaft that traverses the tube which connects the two distributers. This arrangement permits of dispensing with the use of stuffing boxes. As for the steel driving shaft, that is prolonged upon the external face of each turbine, traverses each of the two discharge tubulures through a stuffing box and rests upon two wide pillow blocks, each provided with three lubricating rings. At one of its extremities this shaft carries one of the halves of a coupling box that serves to unite it with the shaft of the dynamo that is placed in a line with it. The pillow blocks are mounted upon strong uprights cast in a piece with the frame.

The turbines are parallel reacting ones, each motor, running two turbines, furnishes 225 h. p. with a discharge of 213 gallons, and a fall of 95 feet, and with a velocity of 400 revolutions a minute.

The following are the principal dimensions of these machines:

Diameter of the tank	3·5 ft.
Length	3·75 "
Mean diameter of distributer	25 in.
Number of effective orifices distributed in two equal sectors to the right and left of the vertical shaft	14
Height of orifices	0·75 in.
Width " "	4 "
Mean diameter of turbine	25 "
Number of orifices	26
Width of "	5 "
Height of buckets	6·5 "
Number of revolutions	400
Diameter of steel shaft	5·25 "
" at the pillow blocks	4 "
Width of the " "	7·25 "

These motors, which have been run for two years, have given excellent results, and their operation, which is very regular, has never caused any heating So it seems that the use of them is indicated in cases when it is desired to utilize falls of large discharge, and to obtain relatively feeble velocities of from 400 to 600 revolutions a minute for directly actuating dynamos, since, under such falls, centripetal turbines would give too high velocities that would necessitate the use of intermediate transmissions.

There is still another case in which centripetal turbines cannot be employed, and that is when it is desired to obtain these same velocities of 400 or 600 revolutions

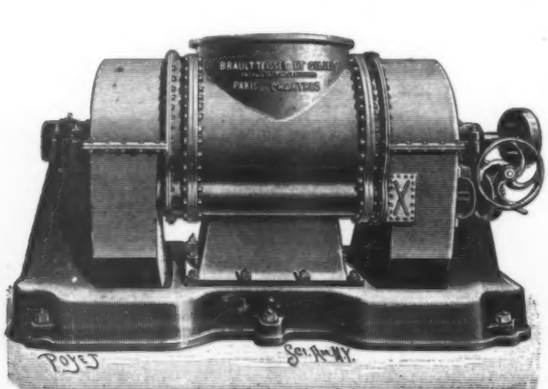


FIG. 3.—MIXED CENTRIPETAL BALANCED TURBINE.

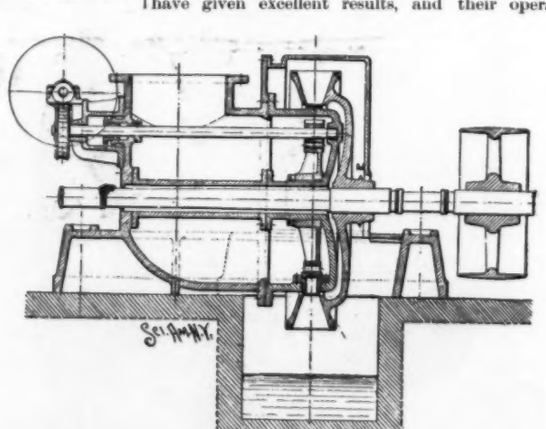


FIG. 4.—CENTRIFUGAL TURBINE WITH HORIZONTAL AXIS AND OF 100 H. P.

with a very feeble discharge and a very large fall. In this case it is possible to employ either Pelton wheels or a centrifugal turbine, a few of the types of which we are going to study.

Fig. 4 represents a turbine capable of furnishing from 30 to 60 h. p. with a fall of 325 ft. and a velocity of 700 revolutions a minute. This motor consists of a delivery pipe forming a frame and connected with the distributer. This latter carries a tubulure that is connected with the elbow of the pipe, thus crossbracing these two points and preventing any flexion of the distributer, which, at its lower part, is provided with a certain number of orifices, the size of which is calculated according to the discharge, and the opening and closing of which are regulated by means of a circular cut-off. This latter revolves around the central tubulure, and the maneuvering of it is effected by means of a handwheel, which, through the intermedium of an endless screw, actuates the shaft that carries the pinion which gears with the rack of the cut-off.

The turbine is keyed upon a steel shaft that rests upon two pillow blocks that are mounted upon a solid cast iron frame which surrounds the turbine. A cast iron tank prevents the water from overflowing in the room.

The principal dimensions of this turbine are as follows:

Mean diameter of distributer	27	in.
Width of orifices	1·6	"
Height	0·4	"
Number	5	
Mean diameter of turbine	28	in.
Number of orifices	44	
Number of revolutions	700	
Discharge of turbine	15	gallons.
Height of fall	328	ft.
Power of turbine	50 to 60	h. p.
Diameter of shaft	3·6	in.
" " " in bearings	2·8	"
Width " " " "	5·5	"

If the discharge of the fall is still less, the delivery pipe will naturally have a much smaller diameter. In this case it is possible to adopt the arrangement shown in Fig. 5, that is to say, to cause the shaft of the turbine to pass over the delivery pipe. The distributer is then reduced to a truncated sector forming a continuation of this pipe and carrying the orifices necessary for the admission of the water as well as space for the cut-off. This latter is thus asymmetrical with respect to the vertical plane passing through the shaft of the motor. As for the rest as the installation, that is like that of the one described above. Turbines of this type have been applied to the running, through belts, of the dynamos used for the lighting of the city of Fort de-France, Martinique.

The following are the essential characteristics of them:

Mean diameter of distributer	36	in.
Width of orifices	1·2	"
Height	1	"
Number	6	
Mean diameter of turbine	3·6	in.
Width of orifices	2	"
Number "	36	
" of revolutions	400	
Discharge of the turbine	25	gallons.
Height of fall	160	ft.
Power of turbine	40	h. p.
Diameter of shaft	3·2	in.
" " " in bearings	3·2 to 2·4	in.
Width " " "	6 and 5	"

power when, for example, it is desired to use the pressure of city water mains for domestic purposes. These small motors, which may be employed for running dynamos, elevators, sewing machines, dumbwaiters, etc., are much used in foreign countries. The turbine is set in operation by means of a simple lever connected with the cut-off that acts upon the distributer. The

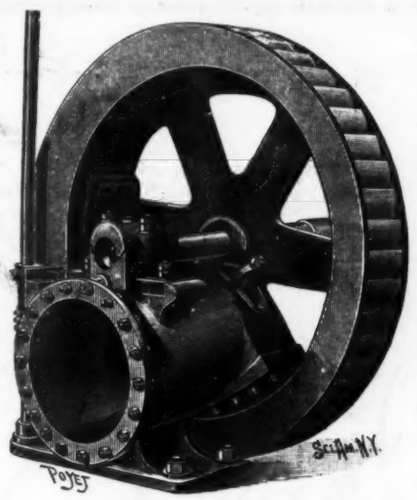


FIG. 5.—CENTRIFUGAL TURBINE WITH HORIZONTAL AXIS AND PARTIAL DISTRIBUTER (40 H. P.)

entire turbine is placed in the interior of a cast iron tank which is absolutely tight. The water is discharged at the bottom through a pipe that may be bolted under the base of the turbine.

The principal dimensions of the type represented in Figs. 7 and 8 are as follows:

Mean diameter of distributer	9	in.
Number of orifices	1	
Width of orifice	0·32	"
Diameter of turbine	8	"
Number of orifices	26	
Width	0·75	in.
Diameter of delivery pipe	1·6	"
Height of fall	160	ft.
Discharge of turbine	1	pint
Power	87	ft. pounds
Diameter of driving shaft	0·75	in.
Number of revolutions	1,375	

In this general study we have confined ourselves to an examination of motors designed for the utilization of high falls, but intend to complete the subject some time in the future by a description of turbines utilizing a low or medium fall of water.—Le Genie Civil.

Reports from the Wilcannia district of Australia state that the drought is being severely felt there. On some stations very heavy losses of stock have already occurred. On one holding alone the manager estimated that the sheep were dying at the rate of 1,000 a day. Within a radius of 100 miles of Wilcannia the country has the appearance of a desert. Right through to Wentworth, a distance of 280 miles down the river Darling, there is not a vestige of feed to be seen, while the seventy mile track toward Hay is in an equally deplorable state. Up the river toward Bourke there is no feed until Windbar is reached, a distance of 120 miles from Wilcannia. In the Menindie district also grave fears are expressed as to the result of the prolonged drought. At the end of last year there was only 837,800 sheep in the district, being a decrease from the previous year of 90,900. The loss since 1893, which has been at the rate of 100,000 per annum, is almost entirely due to bad seasons.

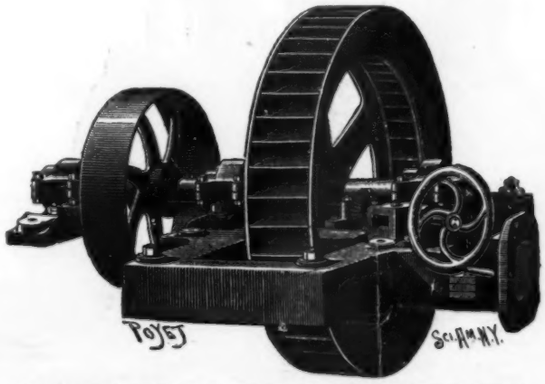
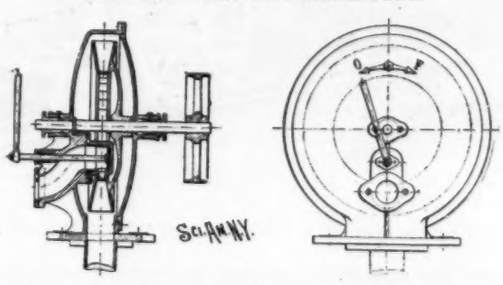


FIG. 6.—CENTRIFUGAL TURBINE WITH HORIZONTAL AXIS AND PARTIAL DISTRIBUTER.



FIGS. 7 AND 8.—CENTRIFUGAL TURBINE OF 87 FOOT POUNDS POWER.

Fig. 6 represents another turbine of the same type established for a still smaller discharge.

Finally, we shall give a description of a turbine of exceedingly small size, established on the same principle as the preceding, and designed to furnish but a little

THE ACCOMPLISHED UTILIZATION OF NIAGARA.*

IN response to your request for succinct data as to the net result of the enterprise at Niagara, in regard to which the Electrical Engineer has made so full a record during the past six years, I am glad to be able to submit figures of a remarkably encouraging character. The project has never promised so well as now, either in practical operations or in those financial results which, as Mr. Brunel insisted, can alone justify even the greatest engineering plan.

Since work was begun in 1890, we have had at least four financial crises, and other influences, deterring the establishment of new industries requiring power. Considering these general and well-known adverse conditions, coincident almost with its life, the wonder is that this company has steadily progressed, and, as above indicated, has virtually reached the point of self-support. Under such conditions, and in view of the necessarily experimental character of the work, it would have been folly at any earlier date to seek to provide for an installation larger than necessary to demonstrate that this enterprise can accomplish real work and promise real profits.

The plans of the Cataract Construction Company and the works of the Niagara Falls Power Company are so far completed that delivery of power to customers in Buffalo has been successfully instituted, and the calls for power under contracts actually executed (and in excess of the present capacity of the works) will provide annual rentals which, with contracts in negotiation, represent a total income from that source falling not far below half a million dollars.

The present electrical installation comprises three dynamos, each of 5,000 electrical horse power, of which one should be kept as a reserve; but the demand has made such reservation impossible, and the contracts already made for 15,825 electrical horse power exceed not only the prudent, but the actual, capacity of these works, which require immediate extension, with every prospect of prompt and profitable employment.

The proposed extension involves doubling the present capacity of the transmission line to Buffalo which, already in successful operation, is delivering 1,000 electrical horse power; the extension of the wheel pit for its full length, so as to have capacity in all for ten 5,000 horse power turbines and 7 dynamos; the installation of seven 5,000 horse power turbines and dynamos, in addition to the three now in operation; and the extension of the power house to cover the new installation. The work of such an extension of the wheel pit is about one-third completed; the right of way from Niagara Falls to Buffalo is complete; the pole line already erected has a pole and cross arm capacity for 20,000 electrical horse power, with copper conductors in place for 5,000 electrical horse power. Upon definite proposals already received, the entire installation above described can be accomplished within the year 1897.

As a concrete presentation of the facts, I will add a list of the contracts for power up to election day, 1896. No more eloquent statement as to results achieved could be given if I were to fill a volume of your journal:

HYDRAULIC POWER.

	Horse Power.
Niagara Falls Paper Company	7,200

ELECTRIC POWER.

Pittsburg Reduction Company (aluminum)	3,050
The Carborundum Company (carborundum)	1,000
Acetylene L., H. & P. Company (calcium carbide)	1,075
B. & N. F. Electric Light and Power Company (local lighting)	500
Walton Ferguson (chlorate of potash)	500
Niagara Electro-Chemical Company (peroxide of sodium)	400
B. & N. F. Electric Railway (local railway)	250
N. F. & S. B. Railway Company (local railway)	250
(All from October 1, 1896.)	
Buffalo Street Railway Company (22 miles transmission)	1,000
(From November 15, 1896.)	
Acetylene Light, Heat and Power Company.	
(From February 1, 1897)	1,000
(From March 1, 1897)	1,000
(From delivery, say, November 1, 1897)	2,000
Mathieson Alkali Works (soda ash).	
(From June 1, 1897)	2,000
Buffalo Street Railway Company	1,000
Buffalo General Electric Company (lighting)	3,000
(From November 15, 1897.)	
Totals	25,225

SUMMARY.

Total hydraulic power sold—Niagara	7,200
Total electric power sold—Niagara	13,025
Total electric power sold—Buffalo	5,000
	25,225

ADDITIONAL.

Albright & Wilson, Limited (electro-chemicals)	400
1896—Grand total	25,625

It will be obvious, at a glance, that Niagara has already started on its career as a great chemical center, and thus justifies the predictions that the chemical trades would center ultimately around the sources of cheap power in large quantity.

* By W. B. Rankine, Secretary Niagara Power Company, in the Electrical Engineer.

EXPRESS COMPOUND LOCOMOTIVE WITH AUXILIARY GEAR.

IN designing the compound locomotive with a single pair of driving wheels, which is shown in the accompanying engravings, the constructors, Messrs. Krauss & Company, of Munich and Linz, aimed at combining the chief advantages of uncoupled wheels with the greater traction force which four coupled engines afford in starting and in mounting gradients, while further they desired to secure a more perfect adaptability of the engine to the various requirements concerning speed and power that arise during ordinary working conditions. Very large cylinders, quite desirable in cases of great power being required at low speed, give unfavorable results at high speeds. If the customary two cylinders are to be adhered to, it is hence necessary to keep down their dimensions. The design adopted by Messrs. Krauss & Company enables them to adapt the dimensions of the cylinders to the conditions obtaining at high speed, while for low speeds they bring into use an auxiliary engine; thus they double their tractive power when needed and can exert a great pull with early cutoff.

It is owing to the willingness on the part of the directors of the Bavarian State Railway, and particularly of the chief of the engine department, Oberregierungsrath Mahla, to test an entirely new arrangement, that this idea has been carried into execution. Having ordered twelve engines of the standard four coupled express type, Class B XI (cylinders 17·52 in. and 26·38 in., 24 in. stroke, 73·2 in. driving wheels, and a steam pressure of 13 atmospheres), the directors conceded that one of these engines should be built on this new plan, provided the construction was such that the locomotive could, in case of failure, be converted so as to fairly resemble a standard engine.

The locomotive herewith illustrated, known as No. 1400, is the only one of its kind. It was delivered in December, 1895, was on regular duty during the months January to March, 1896, was then sent to the Bavarian Exhibition at Nuremberg, and since October, 1896, has been again in uninterrupted service.

Our illustrations clearly bring out the chief constructive peculiarities. Apart from the rear axle, which has its bearings in a short outside frame, the main framing is internal; the cylinders of both systems, as well as their gears and valve chests, lie outside. In accordance with the conditions of easy convertibility, the chief parts are like those of Class B XI. The boilers, e. g., are identical—not reckoning slight changes in the smokebox, necessitated by the alteration in the pipes—and so also are the complete bogie (of the type designed by Mr. James Stirling, Southeastern Railway), and the driving wheels, for which latter the designers would have preferred a larger diameter. Above the rear axle, the main framing is provided with sectors in order to admit of the eventual addition of horn plates for the reception of the axle boxes of a coupled axle, should the present construction not be ultimately approved of.

The main pair of cylinders drive the 73·2 in. wheels; the dimensions of the cylinders are smaller than those of the B class, the diameter of the right hand side high pressure cylinder being 15·16 in. and that of the left hand side low pressure cylinder 24·01 in. The stroke in both cases is 24 in. The cylinders are inclined 6 in 100,

Fig. 3.

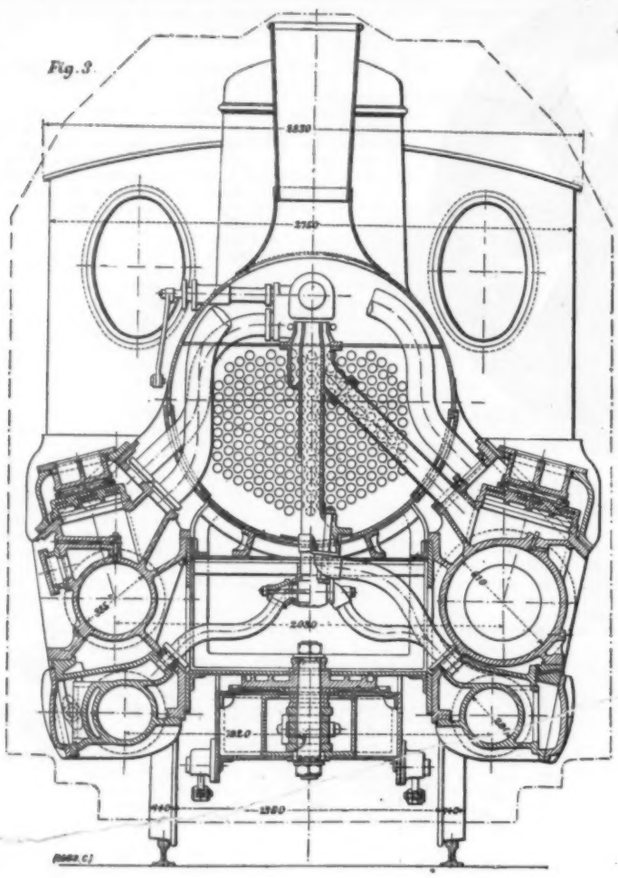


Fig. 4.

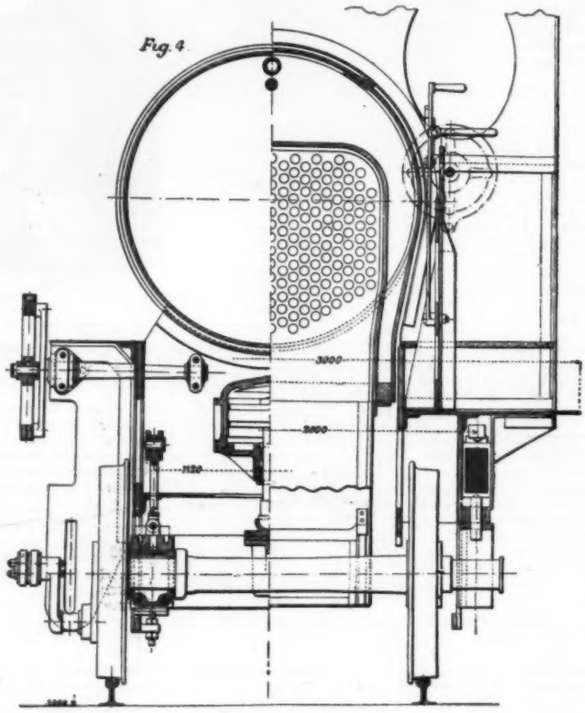
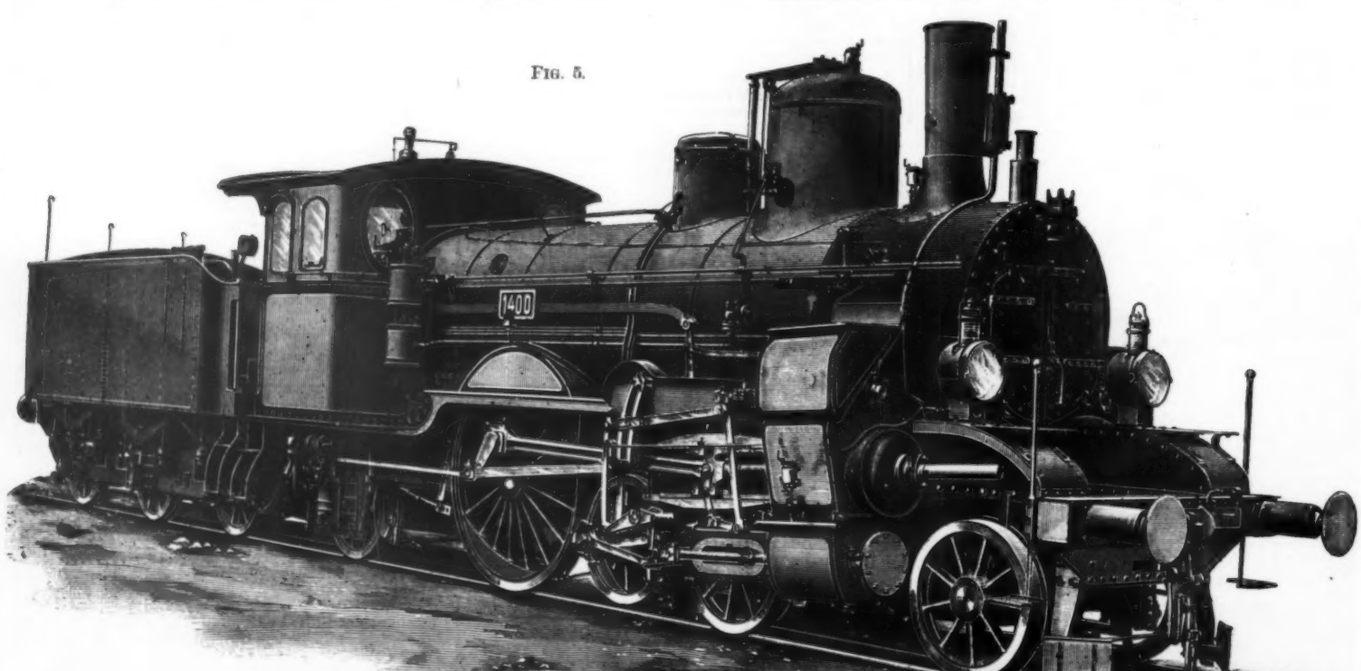


FIG. 5.



COMPOUND LOCOMOTIVE, WITH AUXILIARY CYLINDERS, FOR THE BAVARIAN STATE RAILWAYS.

because the auxiliary cylinders had to be placed underneath, not to interfere with the engine profile. The valve chests, which are fitted with American balance slide valves, also lie inclined, in both the longitudinal and transverse directions. The valve gear is of the Heusinger-Walschaert type. The cutoffs are the same on both sides, while the cylinder ratio is 1 : 2·51.

The receiver pipe passes through the smokebox, and bears above a safety valve loaded to 5·5 atmospheres, and in front a Ricour air suction valve. The exhaust into the chimney takes place through an annular pipe. The starting gear consists of a Lindner cock, which is connected with the reversing rod, and at full gear allows the steam to pass from the boiler to the receiver, and of a Krauss interruption slide, which, fixed outside the high pressure cylinder and worked from the right hand link, prevents the passing of steam at those positions of the crank when the pressure in the receiver would only impede the starting.

The auxiliary engine is intended to insure a reliable and powerful start. It is entirely independent of the main engine, and is fitted, as shown in the engravings, with two equal sized cylinders. It is not in use except when a heavy pull is needed, that is, in starting, and on steep gradients. Under ordinary conditions, the auxiliary engine is not switched in, so to say, and its wheels are kept off the rails and remain stationary. Having regard to the low speed at which the auxiliary driving wheels are to run, and to the circumstance that the weight and bulk of the auxiliary gear should be as small as possible, these auxiliary wheels have been made the same diameter as the trailing wheels, namely, 1 meter (39·3 in.)

The auxiliary driving axle has its bearings in horn plates which are formed by plates riveted to both sides of the main frame. This axle has not any ordinary bearing springs, but is connected with the springs of the main driving axle in such a way that these springs tend to lift the auxiliary axle from the rails and press its bearings against the upper stops. Normally, therefore, the auxiliary driving wheels remain 30 millimeters (1·2 in.) above the rails.

When the auxiliary engine is to perform its duty, the auxiliary driving axle is depressed by the action of the piston of a vertical steam cylinder of 412 millimeters (16·2 in.) diameter, fixed above its center, as shown in Fig. 7. The piston with its ball socket joint and bronze footstep bears against a cast steel support, fixed between two plates which connect the bearings. Steam is admittted through a threeway cock, which is seen on the right hand side of the dome in the perspective view, Fig. 5; at the same point is also a lubricator for the piston. The steam pipe to the cylinder passes under the lagging of the boiler, lest the pipe freeze. An automatic valve in the gear cylinder takes the condensed water down into the ashbox. The steam which is discharged on releasing the shaft was originally permitted to escape as it liked; later on a special pipe was added which conveys this steam into the chimney, in order to avoid soiling the engine by the oil in the steam.

The levers between the auxiliary axle bearings and the bearing springs of the main driving axle serve the further object of equilibrating the load when the auxiliary axle is lowered, in such a way that the load is distributed over the running wheels. When the auxiliary wheels are pressed down, the whole engine is raised about 1 in. on the springs; at the same time, however, the front links of these springs are depressed by about 2 in., so that the deflection of the springs, and consequently the load upon them, remain unchanged. The springs are hence slightly inclined under both conditions. When the auxiliary axle is lowered, their front extremity lies a little lower, when the axle is suspended, a little higher than the other extremity. The forces entering into play are as follows: When the auxiliary motor is out of use, the weight available for adhesion consists of the dead weight of the main driving wheels and their attachments, amounting to 3·73 tons, plus the load on the driving springs amounting to 11·12 tons, making a total of 14·85 tons. When the auxiliary axle is pressed down, however, the following additional adhesion weight becomes available:

	Tons.
Deadweight of auxiliary axle and its attachments	2·130
Pressure on piston of loading cylinder	17·330
	19·460
Less upward pressure exerted at the point, B, by the levers connected to the driving springs	4·635
Additional adhesion weight	14·825

It will thus be seen that the adhesion weight amounts to 29·67 tons when the auxiliary axle is being used, and to 14·85 tons in the other case.

The cylinders of the auxiliary engine, which have a diameter of 290 millimeters (11·4 in.) and stroke of 460 millimeters (18·1 in.), are bolted to the lower side of the large cylinders; their valve chests lie horizontally and point outward. The arrangement is clearly shown by Figs. 3 and 6.

The working gear is shown by Figs. 5 and 6. From these views it will be seen that the crossheads and guides of the auxiliary motor are inclosed within a metallic case, lest dust and dirt from the hind bogie wheels should injure them. The valve gears of both engines are actuated from the same shaft, and are permanently connected in such a manner that during forward motion, which corresponds to equal performances by both engines, the large engine works with a later cutoff. For this purpose the length of the suspension link is such that when the expansion blocks of the large engine are at midgear, those of the small engine are somewhat below this point; a cutoff at 0·4 in the case of the former corresponds to a cutoff of 0·17 in that of the latter. The small engine is fitted with Stauffer grease cups, which are economical and sufficient for the short periods during which this auxiliary engine has to run. For the purpose of lubricating the piston and slide valve, condensation apparatus has been provided which feeds only as long as the engine is under steam.

The regulator slide of the auxiliary engine is put in the smokebox, in the steam pipe of the large engine. As a result the small engine receives steam only when both regulators are open. The rod actuating the auxiliary regulator passes laterally out of the smokebox, and is manipulated by a special handle from the driver's footplate. In order to render impossible any mistakes on the part of the driver, such as giving steam to the auxiliary axle before putting it under load, or releasing it again before shutting off steam, the regulator handle and the shaft which actuate the threeway cock have been made mutually interlocking.

As regards other special features of the locomotive, the mechanical sandbox should be mentioned. In the locomotive as originally constructed steam sanding apparatus was used. But the steam device froze during winter—the Bavarian lines are exposed to exceedingly cold weather—while the mechanical device since adopted has always answered during severe frost. The sand is fed from the box by a screw conveyor with left and right handed thread; the screw is actuated from the right hand link of the main engine in the way we shall explain presently. Above the small gear wheels the sand pipe branches and contains a clack valve, which is controlled by the pull on the threeway cock; thus the sand is strewn in front of either the auxiliary driving wheels, when they are lowered, or of the large driving wheels. As long as the block is at the center of the link, the apparatus will manifestly be at rest.

In most respects the engine under notice is of the usual construction. It is fitted with a Westinghouse brake (which acts upon the driving and the smaller hind wheels), with Petri's recording speed meter, actuated from the right hand eccentric of the main engine, with Körting's safety injectors, with Nathan lubricators for the main cylinders, and with the requisite apparatus for steam heating the train. The locomotive being somewhat longer than those of the standard type, but requiring less water, the limited length of the turntables has caused no difficulties. A small three axled tender carrying 13·7 cubic meters (484 cubic feet) of water has proved amply sufficient; the new standard engines have four-axled tenders on two bogies and carry 18 cubic meters (636 cubic feet) of water. The chief dimensions are:

Boiler:

Grate, length	2181 mm.	(85·8 in.)
" width, front	1021 "	(47 ")
" " aft	991 "	(39 ")
Grate area	2·2 m.²	(23·7 sq. ft.)
Mean diameter of boiler shell	1400 mm.	(55·1 in.)
Thickness of shell plates of boiler barrel	15·5 "	(0·61 ")
Height of center line of boiler above rails	2275 "	(89·5 ")
Number of tubes	226	
Diameter of tubes, outside	45·5 "	(1·79 ")
" " inside	41·0 "	(1·61 ")
Length between tube-plates	3780 "	(148·8 in.)
Heating surface of fire-box, outside	9·9 m.²	(106·6 sq. ft.)
Heating surface of tubes, outside	122·1 "	(1314 ")
Total heating surface	132·0 "	(1421 ")
Steam pressure	13 atm.	

Main Engine:

Cylinder diameter, high pressure	385 mm.	(15·16 in.)
Cylinder diameter, low pressure	610 "	(24·01 ")
Cylinder ratio	1 : 2·51	
Stroke	610 mm.	(24·01 in.)
Driving wheels, diameter	1860 "	(73·2 ")

$$\text{Pull}^{*} = 0{\cdot}52\frac{38{\cdot}5^2 \times 610 \times 13}{1860} = 3280 \text{ kg. (7231 lb.)}$$

Auxiliary Engine:

Cylinders, diameter	290 mm.	(11·41 in.)
Stroke	460 "	(18·11 ")
Driving wheels, diameter	1000 "	(39·33 ")

$$\text{Pull} = 0{\cdot}65\frac{29^2 \times 460 \times 13}{1000} = 3280 \text{ kg. (7231 lb.)}$$

Gear cylinder, diameter	412 mm.	(16·22 in.)

Lengths:

Wheel base of engine	7400 mm.	(291·4 in.)
Total wheel base of engine and tender	13550 "	(533 ")
Length over all, locomotive	10220 "	(402 ")
Length over all, locomotive and tender	16570 "	(652 ")

Weights:

	Single. Tons.	Duplex. Tons.
Bogie	24·15	14·75
Auxiliary driving axle	.....	14·80
Main driving axle	14·80	14·80
Rear axle	12·85	7·45
Total weight	51·80	51·80

Tender:

Diameter of wheels	1000 mm.	(39·33 in.)
Axle distance of wheels	3800 "	(149·6 "

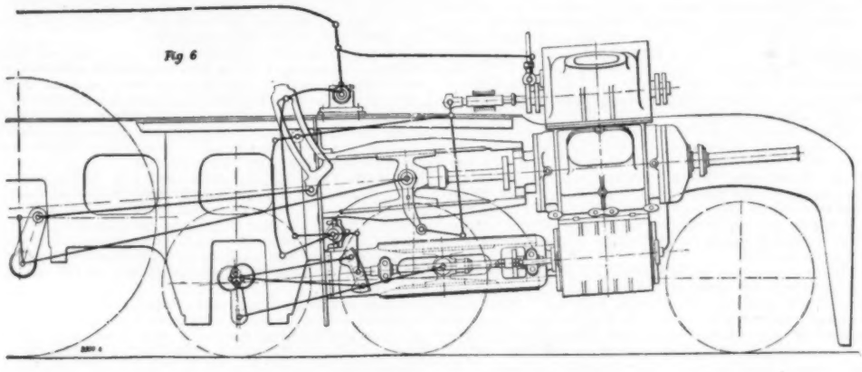
	Tons.
Weight, empty	15·0
" of water	13·7
" coal	5·0
" fittings	0·5
" fully equipped	34·2

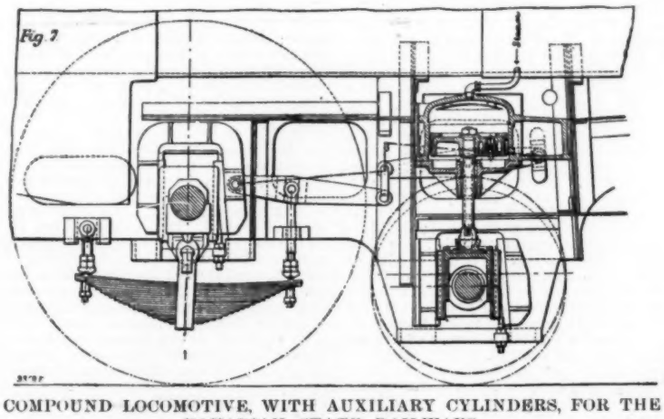
The brake has twelve blocks and acts upon all the wheels.

The above figures show that the total pull of the locomotive is 2 × 3,280 kilogrammes = 14,462 lb. = 6½ tons, which is a high value. In order to facilitate a comparison with English engines, Messrs. Krauss & Company assume a steam pressure of 190 lb. and driving wheels 7 ft. in diameter: they would require cylinders of 25·5 in. diameter, which would not be acceptable for high speed locomotives.

We have already mentioned that the locomotive was first put to regular duty during the months January to March, 1896. This was on the lines Munich-Ulm, Treuchtlingen, Regensburg, Simbach, Salzburg, Kufstein, Kempten. Objections had previously been raised that the auxiliary engine could not be thrown in without a jerk, and that its steam pipes would, owing to their use for short periods after long intervals, be exposed to freezing. Both objections have proved unjustified. The throwing in of the auxiliary engine has taken place when the locomotive was running at speeds up to 75 kilometers, 46·6 miles. The operation was so smooth that persons standing on the engine and not watching the driver did not notice the change over. It has, moreover, been found that the switching in will rarely be required while the locomotive is in motion. It soon became apparent that the help of the small engine was needed over short distances only. It had been calculated that the auxiliary engine would have to help, not only in every start, but at every gra-

* Messrs. Krauss & Company base the pull of compound engines upon the high pressure cylinder, and reckon only 80 per cent. of simple expansion.





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dient of 1 : 200 or more for a distance of about 2 kilometers, 1¼ miles. Under this supposition, the locomotive would, on its regular trip, have had to do about 15 per cent. of duplex working. As a matter of fact, it has resulted that the large engine takes trains of 180 tons alone over gradients of 1 : 100. There is only one long gradient of 1 : 100 and 1 : 94 between Freilassing and Traunstein, on the Salzburg line, where the assistance of the auxiliary engine is required over a distance of 12 miles. Trains of 200 tons are to ascend at a speed of 31 miles (50 kilometers) on this gradient. Otherwise the use of the auxiliary plant is limited to starting and getting up speed after slow runs, and on the whole the duplex working is confined to 5 per cent. of the total track length. During the official tests which took place in March last, the engine hauled a train of 183 tons over a long gradient of 1 : 500 and 1 : 400 with a speed of 54 miles per hour ; on a gradient of 1 : 55, between Miesbach and Schliersee, a speed of 30 kilometers (18·6 miles) was realized, in that case, of course, with the assistance of the auxiliary engine. Snow and ice have as yet not caused any trouble, although severe snow storms, followed by extreme cold and heavy drifts, have been experienced.

The complicated construction and the large number of axles have been commented upon adversely. With regard to the former point, it may be said that the four-cylinder engines of Mallet & De Glehn, whose right of existence nobody questions now, are certainly not any simpler. A four-coupled engine of the latter type has, on the contrary, two more coupling rods and four more bearings, and the secondary mechanism is essentially more bulky than the auxiliary engine. It is further to be considered that De Glehn's secondary mechanism is always running, which means additional friction, oil and repair. With the auxiliary engine under notice, which is idle for 95 per cent. of the run, those additional expenses come in to the amount of 5 per cent. only. There is a further advantage as compared with compound locomotives fitted with change-over gear, in being able to work with fresh steam in both engines. Such locomotives have to resort to strong throttling, and hence to waste steam, while the main and the auxiliary engines of Messrs. Krauss & Company work with full boiler pressure.

As concerns the second point, the locomotive has exactly as many driving and carrying axles as the "American Atlantic" type, which is more and more coming to the front. Together with its three-axled tender, it has not any more axles than the normal "American" class, with its four-axled tender.

The external appearance will probably not please in England, since the locomotive is built on the German "everything outside" style. It must be granted that the two separate and entirely different gears make the engine look somewhat complicated, to which appearance one has first to accustom oneself. But this might be altered. It is manifest that four-coupled locomotives could be provided with this auxiliary gear. Such engines might rival the six-coupled locomotives of the American ten-wheel class. We are indebted for cuts and particulars to Engineering.

OXYGEN, FRESH AIR AND HEALTH.*

ALL biologists agree that oxygen is the prevailing essence of the body ; is the most important agency and is the chief element in the health of man.

The world is seven-tenths oxygen. The great oceans are three-fourths and the water we drink is two-thirds oxygen.

The solid matter of the earth is over sixty per cent. oxygen by weight and ninety per cent. in bulk. If a man weighs 150 pounds, 110 is oxygen, and if the oxygen were set free, it would fill 750 cubic feet of space.

What we call fire is but the dangerous activity of oxygen. The flame you see is but the union of carbon with oxygen. Oxygen is all activity ; its mission is to change ; it tears down only to rebuild ; if it destroys by fire, it saves all the materials and quickly uses them to rebuild something else. It is the great builder of the animal kingdom and is man's greatest friend, for it destroys the bad parts of the living tissues and builds good in its place.

Oxygen may become dead if confined in a close room; that is why we notice that dead smell in rooms that have been closed for any length of time.

Sunlight also has much to do in keeping air in a healthy condition. No plant can grow in the dark, neither can man remain healthy in the dark, ill ventilated room. When the first blind asylum was erected in this State (Mass.), the committee decided to save expense by not having any windows. They reasoned, very logically, as the patients could not see, there was no need of any light. It was built without windows, but ventilation was well provided for, and the poor sightless patients were settled in the house. But things did not go well ; one after another began to sicken and great languor fell upon them ; they felt distressed and restless, craving for something they hardly knew what. After two had died and all were ill, the committee decided to open the windows. The sun poured in and the white faces recovered their color ; their flagging energies and depressed spirits revived, and health was restored. Is this not a good illustration of the necessity of sunlight in the animal economy ?

Take an illustration of the necessity of oxygen in water, which I have told you is of itself two-thirds oxygen in composition. Let it stand in a room any length of time, it becomes insipid ; the oxygen entrapped between its particles has become dead or lost. Take fishes and put them in a limited quantity of water and they soon die. Why ? All healthy water has oxygen entrapped between its particles. The gills of the fish are its lungs, and they take water into their mouths and force it back through their gills and thus take out the oxygen, the same as is done in our lungs ; and as soon as this is all consumed, they die, just as we would do if we breathed carbonic acid gas.

Small bodies of water become slimy and covered with what some call "frog pond," but frogs have nothing to do with it, for if you confine rain water in hot weather, the same thing will occur. There is no water so pure as that you see in the little rivulet dashing over the rocks, as in that way a full supply of oxygen is entrapped between its particles. It is the same with large bodies of water thrown about by the wind. Air is only two-fifths oxygen, but without it there could be no fire. The greater the draught, the greater the fire. You all know that fire burns much better some days than others, from the fact that the barometer is higher, causing a greater pressure on a square foot of air, and is as 1,000 to 623 for moist easterly air, and that which we inhale contains thirty-six times more moisture than pure westerly breezes. If the air was pure oxygen, we should quickly burn up, and when a fire was once started it would finish up the building before the engine could reach it. Fire is the union of oxygen and carbon. You know the electric light has to have carbon.

A drop of blood contains the entire human body in miniature, in that it holds all the elements for a complete being. The blood carries carbon for the purpose of exciting the oxygen, and the air cells of the lungs bring it oxygen, just as the bellows will blow air upon the fire. The greater supply of air, the greater the draught and the more intensely the fire will burn. So life exists just in proportion as we breathe and exercise. In a good sized man there are three million of cells, one half air and the other half blood cells.

I have said that oxygen and carbon have a strong affinity for each other. At birth, at the first inspiration, the oxygen enters the air cells ; a process called endosmosis takes place, whereby the oxygen passes into the blood cells, uniting with the carbon, forming carbonic acid gas, which in turn passes into the air cells (just as the rays of the sun pass through glass) and is breathed out.

Before the oxygen entered the blood cells the blood was full of carbon and dead matter. Carbonic acid gas is the union of oxygen and carbon. If the blood did not get any oxygen, it would not move out of the cells, but when uniting with oxygen it becomes red, vitalized, life-giving blood and immediately starts on its mission through the arteries to every part of the system, there to undergo a change in the capillaries (which are hair-like, hollow tubes), which convey the blood from the arteries to the veins. Here in the capillaries a burning process takes place, just as in the stove. Here the oxygen exchanges its life-giving properties for carbon. It builds and destroys.

Now if there is more carbon than oxygen, that is, if we do not breathe enough air, dead matter remains in the system because there is not enough oxygen to burn up all the carbon. Then there is dead matter left in the system which may cause disease of some organ. This burning is life. If you lift your arm or your little finger, it is necessary that some oxygen should burn up some carbon in order to set free the force necessary to move the muscle.

Fire and heat are simple expressions of force. The engine moves by force of the consuming oxygen and carbon. You burn when you exercise. The more exercise, the faster you burn, and more dead matter is thrown off, for this burning is life, and there is no other way of existing. Does this not show us that all animals should have some exercise in order to keep them in a healthy condition ? We cannot live without burning, and we cannot burn without oxygen, which we only get in the air we breathe, and without it we could not exist three minutes. Were we obliged to rebreathe our own breath we should die in that length of time, as the air we exhale is full of poison. Life depends upon oxygen and must have it. Refuse it or stay in a room where the air is not changed, the blood stagnates, dead matter remains in the system, the muscles put on a tired feeling due solely to this cause, and is cured, not by medicine, but by natural oxygen alone. I say "natural," as chemists can produce oxygen, but it lacks Nature's vitality. When we do not have oxygen enough the heart acts feebly, the impulse of digestion is withdrawn, and the food may ferment in the stomach or pass out undigested and unused ; the blood clogs the brain, the head begins to ache, the dead tissues through the body, instead of being carried off by the exhalations of the lungs and skin, are collected in every nook and corner, where they become a fertile soil in which the bacilli of tuberculosis thrive (as they enjoy just such soil), and are sure to make their nest ; and colds, catarrh, and all other diseases of the air passages find good stamping ground.

All scientists say that oxygen carbonizes the tissues, and whenever carbon and oxygen meet, a fire ensues, as real as in the stove or furnace. This is what keeps the blood up to a much higher temperature than the hottest summer day. One great trouble with human kind is that we do not half breathe. A man weighing 150 pounds should have a lung capacity of twelve pints, while many persons only inhale from two to three pints at each inspiration ; but singers inhale from seven to eight pints.

In a drop of blood there are one million corpuscles, and at each inhalation twenty millions are destroyed and their places are taken by new ones. The oxygen tears down all the worn out tissues. This dead matter is caught up by the blood and whirled back to the lungs, where it again meets oxygen, is purified and goes bounding back through the system.

One great cause of colds, catarrh, bronchitis and pneumonia is that the system has become weakened by being in hot, ill-ventilated rooms, not being supplied with enough oxygen to take care of all dead matter, and in this weakened state persons go out into cold air —a change of 60 or 70 degrees—and take cold, not from getting into the cold air, but by coming from overheated, sealed up rooms. If we were more in the habit of warming our blood in winter by taking brisk exercise "under the canopy," and less inclined to coddle ourselves up in nearly hermetically sealed rooms warmed with hot air furnaces with a tropical temperature, we should be a far healthier people. The presence of dead matter in the system is the cause of most diseases, and as oxygen is the greater factor in preventing them, I have thus emphasized its effect on the system.

I have said blood dies every second ; that it loses its character of being blood ; therefore, we conclude nutrition of the body consists of the white disks and the vitality in the red disks.

If, after eating pure food, fresh outdoor air is breathed, the blood will show a large increase in red corpuscles, but by drinking tea, coffee or other stimulants the red disks are decreased in serious proportions. Loss of sleep would do the same. Now before a cold is caught the white corpuscles must be diminished by weakness, preventing the blood from assimilating food. This being the case, we should let all stimulants alone, eat such food as will be readily assimilated to restore the white corpuscles and take a full supply of fresh air to transpose them into red disks. Colds should be looked after, as they often start their victims toward the grave, but no half breathing will do this. Nine-tenths of the human race do not half breathe, consequently the blood is not in a healthy condition ; but full, deep inspirations many times a day, with perfect exhalations, will make the blood healthy and send a cold kiting.

Oxygen is indispensable in the food we swallow to insure perfect digestion. The teeth were made for a mill to grind the food, and during this process both oxygen and saliva are mixed with it. Persons who have lost their teeth or bolt their food are more liable to become dyspeptic from the lack of oxygen and saliva, as these are the most active promoters of digestion.

We often see pale, anemic young ladies ; they need not be so if they would eat proper food and fill their lungs with fresh air, which is free to all. They live mostly on bread, sweetmeats and candy, food ill fitted to make white disks ; consequently what little oxygen they get cannot make red disks, as there is not proper material by which nature can perform her duty. The system is full of dead soil, the person becomes debilitated and is a fit subject for tuberculosis germs to make lodgment in, for that is just the soil they like and in which one will produce over sixteen million in twenty-four hours, as they double every hour. Figure it up and see if I have the figures large enough.

There are two gallons of blood passing through the lungs every twenty-four hours, requiring more than three thousand gallons of pure air to change it from death to life giving blood. The colorless young ladies spoken of do not more than a quarter breathe ; probably most of them do not inhale more than two or three pints of air at each inspiration, when it should be from six to eight to change the blood and rid the system of the dead matter which is clogging it.

If a person inhales enough fresh air and has disks enough to keep up a good fire, the bacilli tuberculosis will burn up, as they cannot stand such a fire. Fresh air is a germicide. To illustrate how quickly the air in a room may become impure, I will cite a school room examined in Boston. Two hours after the children had been in session there was found eighteen times more carbonic acid gas than there should be to keep them healthy. Many of you remember the black hole in Calcutta, where 146 prisoners were put into a close prison and only 23 were found alive in the morning, and most of those died of typhus fever in a short time. After the battle of Austerlitz 300 prisoners were placed in a prison and 260 died in a very short time. This shows us very clearly the effects of bad air on the animal economy.

A few words about consumption.

Bacilli germs make a lodgment in the lungs, and, like a besieging army around a city, every weak point is attacked, and the weaker the lung, the greater the predisposition to consumption. At night the rooms are shut tight to exclude all fresh air possible ; they have on double windows and cotton stuffed in every crevice where it is thought there is a chance for fresh air to enter ; then occupants feel weak in the morning and wonder how it is they take cold so easily. They think there must be something wrong about their system and consult the doctor. I have noticed that children who have bronchitis or pneumonia (especially among the poorer classes) are usually worse in the morning, when we should expect to find them better. Why ? During the day, especially where there are children, the door is opened every few moments and in comes a gust of fresh air, but in the evening, as soon as they are in bed, the door is shut for the night, and this may be cleated so that there is no chance for fresh air to enter the room of the sick child. Between the stove, mother and child all the oxygen is soon consumed. The child's lungs are so diseased that they can take in but little air, consequently need that of the purest kind, but this they cannot get in these close rooms, and many a parent has been made to mourn the loss of a dear child simply because she thought if it got a breath of fresh air it would take cold. It is the same with consumptives. When the cool weather comes they shut themselves up in hot, ill-ventilated rooms or go south, where the air is rarefied by heat, instead of taking exercise several times a day in open air and filling their lungs to their utmost capacity. They never inhale more than a third of what they should to burn up the bacilli that have made a lodgment in that part of the lungs which have been deprived of fresh air. They shut themselves in close, ill-ventilated rooms in the fall, and do not permit themselves to get a breath of fresh air until spring. One bacillus in such a lung will produce more than sixteen million in twenty-four hours. They often spit upon a handkerchief, and each sputa contains three million germs and in twenty-four hours over six billions. If any of this sputa dries, the germs float and we inhale them, we breathe them in, and if they find the right soil, you can see how fast they propagate. You hear a great deal about consumption being contagious. The germs are floating everywhere, even in this room, but don't be alarmed. Physicians, nurses, members of the family in attendance, washerwomen and ragpickers never take it if they get a fair amount of fresh air. If you could only see the air of this room under a microscope, you would want to get out. As fresh air is a germicide, no one ever need take consumption, as fresh air costs nothing. I always expel all the air from my lungs when I leave a crowded room, and fill them with fresh air as soon as I get outside.

Be sure to have your sleeping room windows open more or less, as the weather may be, and you will be less subject to take on any disease, which is usually brought on by overeating, eating at improper times or improper food and staying in ill-ventilated rooms.

* By L. W. Curtis, M.D., in Health Culture.

The results obtained by the Nobel Dynamite Corporation in 1896, while not quite as good as expected, have been sufficient to warrant the payment of a dividend of 12 per cent. for the year, says the Engineering and Mining Journal. The capital is $9,127,000, in $50 shares. The net profits in 1896 amounted to $1,101,560, and the sum paid as dividend was $1,080,450. The report says that the business was good during the year, except in Germany. It is proposed now to establish factories in the United States.

ENGINEERING NOTES.

In April last there were recorded 105 train accidents in the United States, of which 36 were collisions, 63 derailments, and 6 other accidents. Nine accidents were due to road defects, 32 to defects in equipment, 15 to negligence, 4 to unforeseen obstruction, while 42 are "unexplained."

The production of coal in France in the second half of last year amounted to 14,726,849 tons, as compared with 14,311,596 tons in the corresponding period of 1895, showing an increase of 415,253 tons. Of the coal raised in France in the second half of last year, 8,791,888 tons, or about 60 per cent., were produced in the basin of the Nord.

There has been forged at Darlington, and is to be sent to Belfast, a stern frame weighing 41 tons; while after brackets are still heavier—55 tons gross. These castings are records in weight, for the Oceanic, now building in Belfast. It is, however, a curious feature in the story of the building of this modern leviathan that most of the material will be rolled, cast, and forged in England for this Irish-built steamship.

In the course of the experiments on materials which the United States government have instituted, stone was not overlooked. According to the American Architect, it has been found that the temperature and moisture have a very great influence in determining the resistance of stone. In order to measure the permanent expansion which is known to take place in stones after soaking in water, a large number of samples were soaked in water at 33° Fah., then in water at the boiling point, and again in cold water, and afterward dried. On measurement, all the stones so treated were found to be larger than before, the actual linear expansion being from one-fifth to one-tenth of one per cent. On testing for resistance to various strains, however, the strength was found to be greatly affected by the water treatment.

The London Times says: "The congress of the German and Austro-Hungarian Association for the Promotion of Inland Navigation has just been held in Vienna. A protest was raised against the agrarian opposition to the development of inland navigation. It was pointed out that the agricultural classes greatly underestimated the value of such facilities for disposing of their products. Among other projects reported on were the Danube and Oder, and the Danube, Moldau and Elbe canals, and the proposed connection of the river Isar at Munich with the Danube. The question of utilizing the water power in the Moldau-Danube canal to generate electricity was also considered. The Biwa-Kioto canal, in Japan, was referred to as providing power not only for traction on the canal itself, but for lighting towns along its banks and for driving the machinery in a number of factories."

There was recently launched from the Elswick shipyard of Sir W. Armstrong, Whitworth & Company (Limited), Newcastle, the first-class cruiser O'Higgins, which is being built to the order of the Chilean government. The principal dimensions of the O'Higgins are as follows: Length, 412 ft.; breadth, 63 ft. 9 in.; draught (mean), 22 ft.; displacement, in tons, 8,500. Her armament will consist of four 8 in. Elswick quick firing guns; ten 6 in. Elswick quick firing guns; four 4.7 in. Elswick quick firing guns; ten 12 pounder Elswick quick firing guns; ten 6 pounder Elswick quick firing guns; four machine guns; three torpedo tubes. She has an armor belt extending over the greater portion of her length, 7 ft. wide, and 7 in. to 5 in. at the ends. The two barbettes, containing 8 in. guns, are of steel 6 in. in thickness. The casemates are 6 in. thick, and the conning tower 9 in. thick. The protective deck is 2 in. to 1½ in. in thickness. The total coal capacity is 1,200 tons, and the guaranteed speed is 21¼ knots. The O'Higgins is sheathed with wood and coppered.

The Purdue University has closed a contract with the Schenectady Locomotive Works for a new locomotive to be used in its engineering laboratory, in connection with courses in railroad engineering, says The Engineer. The new locomotive will possess a number of features which are quite new. It will carry a steam pressure of 250 lb. and will have cylinders so arranged that it may be used as a simple or a compound engine. The cylinders and saddle will be made up of different castings, and the centers will be so chosen as to allow the use of cylinders up to 30 in. in diameter. Several cylinders will be provided, and these, with a suitable series of bushings, will allow for different cylinder ratios in compound work. The whole machine will thus afford facilities for dealing with conditions quite beyond the limits of present practice. From its place in the laboratory, the old locomotive, hereafter to be known as "Schenectady No. 1," and which in the course of its six years' sojourn in the laboratory has been run an amount equivalent to 20,000 miles, and has served in an experimental study of many important problems connected with locomotive design, will pass into active service on the road, while the new engine, "Schenectady No. 2," will take its place upon the testing plant.

Since the introduction of torpedo boat destroyers considerable inconvenience has been experienced in consequence of the excessive vibration which is set up when these vessels are steaming at high speed. Various experiments have been carried out by the dockyard officials and naval engineers with a view to discover some means to overcome the difficulty, and in some cases the vibration has been somewhat reduced. Messrs. Laird Brothers, of Birkenhead, who have already completed six destroyers of various types and have four more in course of completion, have apparently solved the problem by a series of successful experiments in the Quail, a thirty knot destroyer, recently delivered at Devonport. This vessel underwent a trial with two balanced weights, weighing collectively 540 lb., fitted to her high pressure crank webs, while two more weights, weighing collectively 645 lb., were attached to her low pressure crank webs. The engines were run at various revolutions up to their full speed, and the corresponding vibration of the vessel was noted. It was found that the vibration, both horizontal and vertical, at a speed of 280 revolutions, was only one-half that which had been recorded before the balance weights had been fitted, while the engines ran steadily throughout.

MISCELLANEOUS NOTES.

The United States Department of Labor estimates the value of goods produced in the various penitentiaries of the States and Territories in 1895 at about $20,000,000.

The existence of a clear, crystal-like mineral, which, when looked through, produces two images of a single object, is one of the curiosities of science. It is stranger still that the only known supply of this double refracting spar is found in Iceland, and is controlled by the Danish government. The mine is located on the east coast of Iceland, about four miles from the trading station of Eskifjord, on the montainous slope 350 ft. above the sea level. This mineral is used largely in optical instruments, polarization apparatus, and the like, and as the supply of the mined mineral has been exhausted, the mine having been closed for some years, the Danish government has recently leased the mine to its former owner. A pound of this mineral is worth about twenty-seven dollars.

America is still maintaining its new reputation as an exporter of manufactures, says Industries and Iron. The returns for March of this year, recently issued, show that the valued total exceeded by no less than $2,000,000 the heaviest preceding totals for the same month, and exceeded by 30 per cent. the total for March, 1896, and by 60 per cent. the total for March, 1895. The whole of the figures relating to this relatively new traffic are too long to be enumerated here; but, taking them as a whole, their general aspect seems to show that the United States is in possession of what may very likely prove to be a staple, even if not a greatly increasing, trade in her manufactured products abroad. It is true that the promises of extensive exports of steel rails and billets have hardly been carried into effect, but in cycles and machine tools there is clearly a rapidly expanding commerce, with England particularly.

According to L'Echo des Mines, Paris, bullets of paper covered with aluminum are the latest thing in ammunition. "This invention, made by a French officer, tends to do away with the seriousness of wounds made by lead balls, or those with steel coverings, owing to the rupture of the bony parts. According to the patent granted to Richard Lüders, of Gorlitz, the precision of fire is in nowise affected, but the passage made by the projectiles through the body is absolutely straight and permits of a rapid closing of the wound. As the number of the wounded will be as large as formerly, and as in most cases their incapacity will be as complete, we ought to look upon this discovery as calculated to satisfy the sentiments of humanity. But, nevertheless, the innovation has small chance of success, for we must recollect that, in war, unfortunately, the end sought is to put the largest number of men possible into a condition where they will be unable to bear arms for the longest time."

In the June Century there is an article by Prof. W. O. Atwater giving the results of experiments at Wesleyan University, during which men remained for several days in a small, copper lined room. The object of the experiments was to determine "How Food is Used in the Body," and Prof. Atwater says: The inference is that the people in professional and business life in the United States, where labor is mostly mental and indoors, are inclined to eat more than they need, and that the special excess is in the fuel ingredients, that is to say, the fats and carbohydrates. Taking the results of these and various other experiments together, the details of which cannot be quoted here, we are, I think, justified in believing that the diet of a very large number of people is out of balance. It contains an excess of food material, and this excess is largely due to the eating of fat meats, sugar, and the starchy foods. These results of accurate observation and experiment thus accord with and explain the current opinion of hygienists as to our ordinary habit of overeating.

On steamships one often hears the expression "slip of the wheel," says the Mining and Scientific Press. Now the meaning of this may be explained in a very simple manner. It is the difference between the actual distance run and the distance that would have been covered had the propeller acted upon a solid substance instead of a fluid. In other words, the expression may be understood as the lost motion of the propeller. It is usual to allow a certain number of revolutions to the propeller or paddles to the mile, and at the end of a stated time the estimated distance run by the ship, according to the number of turns made, is compared with the actual distance run by the ship according to observation of the heavenly bodies or by the patent log, and the difference between these two records is expressed as a percentum and entered in the log book as "slip of wheel." Retardation by reason of head winds and high seas comes under the head of slip. For example: If the distance run according to revolutions is 100 miles, and the actual distance run is 75 miles, the slip of wheel is 25 per cent.

It is an idiosyncrasy with Prof. Hughes, inventor of the microphone, that his remarkable inventions have all been worked out with the most simple and commonplace tools. Thus, in devising the microphone, the apparatus was of the most primitive character, and, with the exception of a Bell telephone receiver, could not be appraised at more than a few pence. This apparatus had a child's halfpenny wooden money box for a resonator, on which was fixed by means of sealing wax a short glass tube filled with a mixture of tin and zinc, the ends being stopped by two pieces of charcoal to which were attached wires, having a battery of three small Daniell cells—consisting of three small jam pots—in circuit. The wires were led away to a Bell telephone placed in an adjoining apartment. The money box, which had one end knocked out, served as a mouthpiece or transmitter, while a Bell telephone was used as a receiver. Sounds scarcely audible, and some absolutely inaudible, to the unassisted ear, were by means of this apparatus delivered with startling loudness through the Bell telephone. Numerous experiments of the utmost importance to physicists were carried out by Prof. Hughes with this apparatus, and with modifications of it, all proving that he had succeeded in producing the simplest and most powerful electric articulating telephone ever known.—Invention.

SELECTED FORMULÆ.

Aureol, a New and Harmless Hair Dye.—A writer in the Deutsche Med. Zeitung contributes the following formula for making a perfectly harmless hair dye which, from the golden tint produced, is called aureol. The dye consists of two liquids, used in equal parts. The first is a 3 per cent. solution of hydrogen peroxide. The second consists of—

Metol	10 parts.
Amidophenol hydrochlorate	3 "
Monamidophenylamin	6 "
Sodium sulphite	5 "
Alcohol	500 "

Dissolve the sodium sulphite in the alcohol, and add the rest of the chemicals. In use equal parts of the two liquids are taken, and only so much as is necessary at the time should be mixed. The hair is first freed from grease, etc., by washing with plenty of soap and thoroughly rinsing, and, after drying, the dye is applied with a comb with fine teeth.—National Druggist.

Test for Lubricating Oils.—The American Electrician gives the following simple tests for lubricating oils: A good test for oil is to place single drops of different oils in line upon a piece of plate glass about 2 feet to 2 feet 6 inches long, one end being raised about 6 inches to 8 inches to form an inclined plane. This test should be conducted in a room where there is little or no dust. The drops of oil start from the top of the inclined plane upon a race with each other. The first day sperm oil will be found in the rear, but after a time it will overtake the others, and be found in motion even after some others have dried up. An oil having a light body runs quickly and dries quickly, but an oil that has both a body and a free flow will readily be detected by this test. An oil may have a good body and yet tend to gum badly, which quality will also be easily detected upon the glass. A good test for the presence of acids is to put small quantities of oil in copper dishes, which are easily made by depressing bits of sheet copper with a round faced hammer. If acid is present, it will attack the copper and produce verdigris. As a result of experiments carefully made and extending over a year, it was found that iron was least affected by seal oil, and most by tallow oil when it is not deacidized. Brass is not affected by rape oil, least by seal oil, and most by olive oil. Mineral lubricating oil has no action on zinc and copper, acts least on brass and most on lead. Lard oil acts least on tin and most on copper. Sperm oil acts least on brass and most on zinc. From the tables given it is found that mineral lubricating oil has, on the whole, the least action on the metals experimented with, and sperm oil the most. For the journals of heavy machinery, either rape or sperm oil, in admixture with mineral oil, is the best to use, as they have the least effect on brass and iron, which two metals generally constitute the bearing surfaces of all engines.

Heat Indicating Paint.—"At a recent meeting of the (London) Physical Society," says Industries and Iron (Lit. Digest), "Dr. Thompson exhibited specimens of a heat indicating paint composed of a double iodide of copper and mercury, originally discovered twenty years ago by a German physicist. At ordinary temperatures the paint is red, but when heated to 97° C. (206° F.) it turns black. Paper painted with this composition and warmed at a stove exhibits the change in a few seconds. A yellow double iodide of silver and mercury is even more sensitive to heat, changing from yellow to dark red at a temperature of 45° C. (113° F.) Many suggestions have been made from time to time as to the utility of such a paint; for instance, it has been suggested that it might be used on machine bearings to give warning of their heating, but we opine that the costliness of the material would in a great degree prevent its adoption either for this or any other of the numerous purposes to which it might otherwise be well applied."

Ant Exterminator.—(1) Powdered borax sprinkled around the infested places will drive them away, as also will powdered cloves. Grease a plate with lard, they will leave sugar to go to it, and then turn them into the fire; cracked nuts will answer the same purpose. Oil of turpentine run into the cracks with a sewing machine oil can.

(2) A good preventive for the inroads of ants is a stripe of carbolated petrolatum about half an inch in width drawn about the places frequented.

(3)

Cape aloes	1 pound.
Water	1 gallon.
Boil together and add to the mixture:	
Camphor, in small pieces	6 ounces.

(4) Sprinkle their haunts with quicklime containing a twentieth of its weight of powdered camphor.—Pharmaceutical Era.

Photographic Hints and Formulas.—

From Liesegang's Photographischer Almanach.—(Amer. Photo. Jl.)

Varnish.—Ground glass substitute (Lanier):

Ether	100 c. cm.
Sandarac	10 grm.
Dammar	3 "
Dissolve and filter, then add	
Benzole	50–60 c. cm.

The more benzole, the coarser the grain.

Varnish (Valenta).—

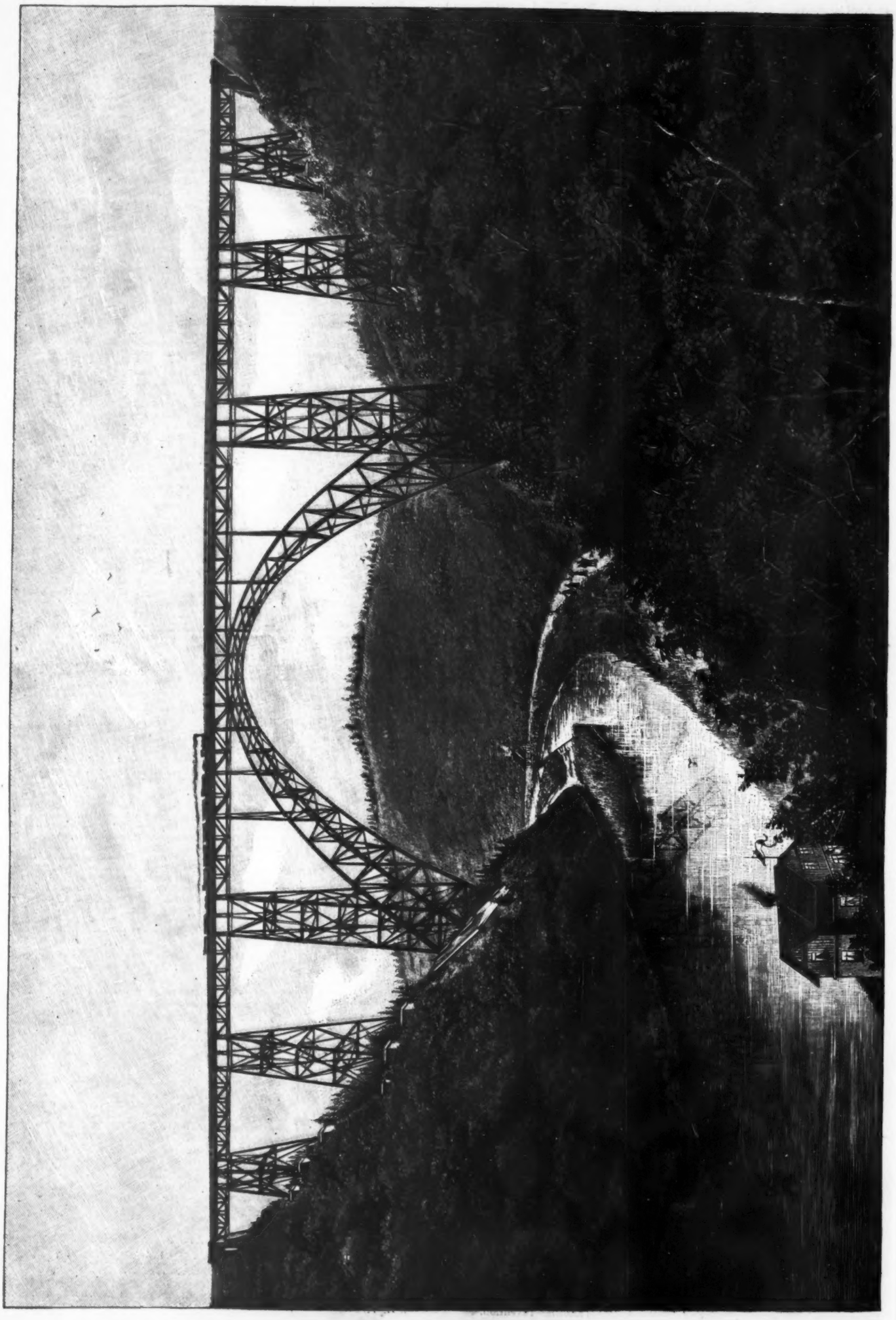
Benzole	400 c. cm.
Aceton (pyroacetic spirit)	400 "
Alcohol (absolute)	100 grm.
Sandarac	100 "

The solution is to be warmed in a water bath and filtered, the negative can then be coated without previous warming.

Retouching Varnish for Negatives.—

(a)	Alcohol	80 c. cm.
	Sandarac (pulverized)	15 grm.
	Turpentine	5 c. cm.
	Oil lavender	4 "
(b)	Alcohol	22 c. cm.
	Ether	2 grm.
	Camphor (crushed)	5 "
	Water	10 c. cm.

Both solutions are to be mixed several days before wanted, then decant and filter. The hardness of film increases with time.



THE RAILWAY BRIDGE OVER THE WUPPER VALLEY AT MUNGSTEN—303 FEET HIGH.

THE MUNCSTEN BRIDGE.

ON the day of the hundredth anniversary of Emperor I a peculiar fête was celebrated in the Rhine province. On that day the final touch was put to the bridge over the Wupper Valley at Müngsten.

The imposing structure was gay with numberless flags, and in the hours of the forenoon, accompanied by the joyful strains of a band, a procession of one hundred and twenty workmen approached. At their head were the directors and chief engineers of the Nuremberg company that had undertaken the building of the bridge and other great technical men. At the giddy height, in the middle of the vast parabola, a halt was made, and with the words, "To advance the common weal, to facilitate the traffic and in appreciation of the technical art!" the last three rivets were inserted. Then all joined with full vigor in the chorus of the well known hymn, "Nun danket alle Gott," and finally a good drink of beer from a mighty cask was enjoyed.

The total length of the bridge is 1,600 feet; the span of the arch is 524 feet; the breadth of the supports, 91 feet.

The pillars at the ends of the arch are 215 feet high; those on the banks, standing 98 feet and 147 feet apart respectively, are 154 feet and 78 feet high. The construction for the double tracks, which rests on the pillars, etc., is 19 feet high. The four abutments for the arch cover a total area of 3,767 square feet, and the sixteen stone bases of the four pillars on the banks 1,937 square feet.

In dimensions this bridge is, on the European Continent, surpassed only by the Garabit viaduct in southern France, which is built similarly, but rises 400 feet above the valley, and whose arch has a span of 541 feet.

The construction of the Müngsten bridge was begun from either side in the summer of 1893, and after all but the main span had been completed the free assembling of the span was commenced in 1896, in a manner never before attempted in practice.

The pillars on each side were connected by means of steel cables 3½ inches in diameter and were fixed by anchorage on the rock by means of hydraulic power.

Rotary cranes placed on the extremity brought ready mounted parts of 8 to 12 tons weight to their place of destination, where they were held suspended by ropes and mounted from traveling scaffolds. In this way the work progressed along the pieces added, and expensive scaffolding was avoided.

Unfortunately, some accidents are to be recorded as having taken place during the building, as, in spite of all precautions, three workmen found their death through falls from the structure. The opening of the new railway line Solingen-Reinsheid was intended to take place on July the first, and so a direct connection between the grand duchy of Berg and the lower Rhine is made.—Illustrirte Zeitung.

THE RAILWAY BRIDGE OVER THE WUPPER VALLEY AT MUNGSTEN—305 FEET HIGH.

PUNCHING AND SHEARING MACHINES.

WE represent herewith a combined punching and shearing machine, and a simple shearing tool for profiled iron and steel, both manufactured by Mr. John Cameron, of Salford. The first of these interests more particularly ship builders, boiler makers and manufacturers of metallic framework. At its right it carries shears, at its left a punch, and in front a double punch for forming in the iron plates or the irons that constitute the carlings resting upon a vessel's floor timbers, or, if need be, in the latter themselves, the conduits arranged at the bottom of the hold to facilitate the circulation of water and allow it to flow toward the bilge pumps.

One of the punches is 3 inches in diameter and is capable of piercing carlings three-fourths of an inch in thickness. The other, whose rectangular section measures 2·25 inches by ¾ of an inch, serves for forming delivery channels in plates 0·9 of an inch thick. The hollow or overhang of the two branches of the frame is equal in both cases to 21 inches.

The two punches are capable of being actuated separately. They are used in rotation, and this dispenses with changing the punches and prevents the loss of time caused by this operation in machines provided with a single punch.

The punches are mounted in a strong cast steel carrier bolted to a cast iron slide actuated by the eccentric of a steel shaft. The rear part of the frame of this double punch is carefully trued, dovetailed together and bolted to the front of the principal machine. The punch placed at the left of the latter is capable of forming holes 1⅛ inch in diameter in iron plates of the same thickness. Its soft steel slide is provided with a starting mechanism and is actuated by a cam device that gives the punch a quick elevation followed by a pause. The hollow of the frame measures 34 inches.

As to the shears placed to the right of the machine, those are capable of cutting plates 1¼ inch in thickness at a distance of 34 inches from the edge, since the hollow of the frame is identical with the preceding.

The flywheels of these tools are of cast iron. At the place where the cams act, they carry tempered steel plates, and, at the front, coupling rods that serve to elevate the punches.

To the third face of the whole, that is to say, to the back, is bolted the steam motor that actuates the three tools. The whole weighs twenty-nine and a half tons.

The use of special machines for shearing or rapidly and cleanly cutting profiled iron and steel, at right angles or according to any degree of obliquity, is indispensable in shipyards as at points where large iron frameworks or bridges are under construction.

The methods employed must not only assure a clean and accurate cut, but also prevent any distortion at the extremities of the pieces acted upon. They must also permit of passing, without complication or loss of time in regulations, from one dimension to another for the same profile and from an angle iron to an I iron, or from the latter to a U or a Z iron, according to the needs of the moment.

Mr. Cameron has devised several types of machines to this effect, all of which are identical in principle and consist essentially in the use of a flat blade cutting by its edges and presenting either a central piece or two lateral pieces that first enter the metal and prepare the way for the oblique cutting edges, which penetrate the metal progressively up to a complete shearing.

This blade operates between three pairs of counterblades fixed permanently in the base of the machine, which, at this place, presents a wide rectangular cavity. Two of these pairs are vertical and at right angles with the third, which is consequently horizontal. They thus extend along three sides of the cavity in the base. Moreover, one counterblade of these pairs is in front of, and the one that corresponds to it behind, the movable blade, and between them there is sufficient space to allow the latter to pass. The blade, in its descent into this sort of matrix, acts after the manner of a cutting punch upon the beam to be sheared, and removes therefrom a band of metal of the same width as the latter.

It is possible also to cut Z irons with these machines, but in this case the wings, during the operation, necessarily undergo stresses that tend to distort them.

This tendency, moreover, is so manifest that, for profiles of this kind, Mr. Cameron has devised a special shearing machine.

The two models of machines, a double and a simple one, that have been devised for this purpose are shown in Fig. 2. They are characterized by the use of two movable blades, a and a', that operate conjointly with two fixed counterblades, b and b'. In the double shears, a set of blades is arranged on each side of a piece, c, which is jointed at its lower part to the base, h, and is moved upward by the eccentric of a central shaft that receives its motion from spur gears actuated by a belt or by a special motor. The driving mechanism is identical in the simple shears, but its eccentric shaft actuates a frame, d, that slides in the base and carries a simple set of blades.

One of the movable blades, a, is fixed directly to the piece, c, or to the frame, d, while the other, a', is carried by the slide, g, which is regulatable by means of a screw and nut. A similar arrangement is given to the counterblades, b and b'. The first is stationary, while the second is mounted upon a slide, i, which may be displaced by a screw carrying a maneuvering hand wheel. The operator is thus able to regulate the position of the blades, a' and b', according to the height of the web of the Z iron. The cavities formed in the base for the passage of the iron to be cut, as well as the form of the slides, i and g, permit of giving the oblique position that corresponds to the angle of cutting.—Revue Industrielle.

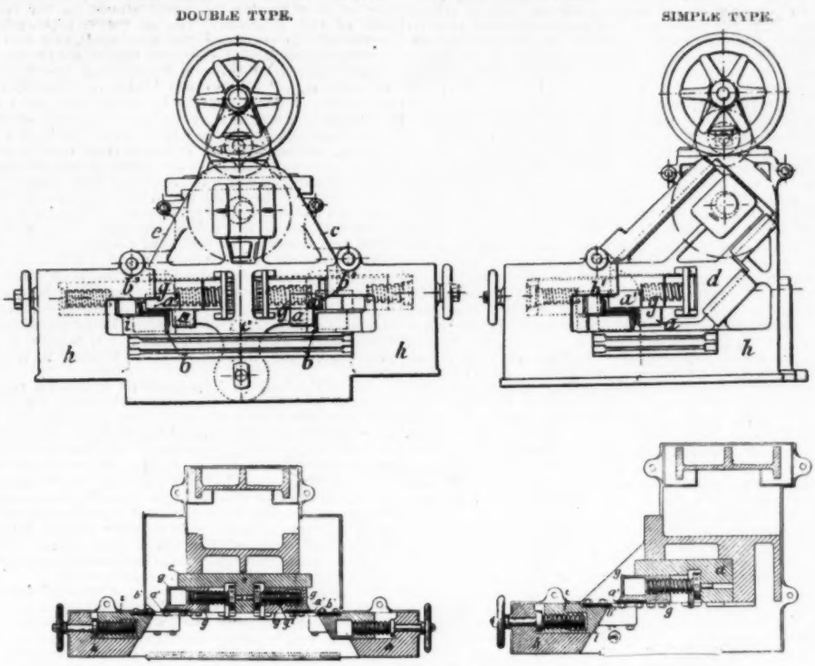


FIG. 2.—SHEARING MACHINE FOR Z IRONS.

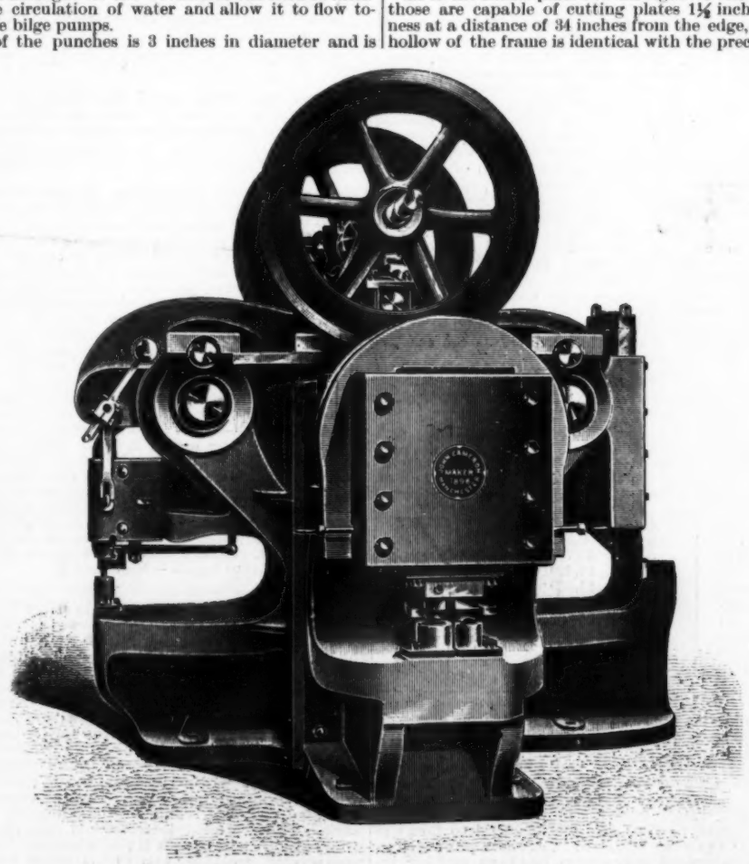


FIG. 1.—COMBINED PUNCHING AND SHEARING MACHINE.

On his new Arctic expedition Lieut. Peary intends to take with him not only Esquimau men, but also women. The Esquimau is a pronounced family man, and prefers his wife to the North Pole.

BRITISH VERSUS AMERICAN MANUFACTURED PRODUCTIONS.

WE are accustomed to hear it said that the American people are a people of great inventive genius; that they are more adaptive, and possessed of greater mechanical skill than our own people; and that they are destined in course of time to become the mechanical engineers and manufacturers of the world. No doubt the American machine tool makers and locomotive builders have made progress during recent years. But they have now had a considerable time to get their hands in, and should be able, if ever they are to make headway against European countries, to make it now. They have cheap raw materials, fairly cheap labor, home protection, and other elements in their favor, and yet they only export machinery and motors of all kinds to the value of about two and a half millions sterling a year, as compared with an average of about six times that value exported from the United Kingdom under the same heads. Nevertheless, the United States are undoubtedly "on the make," and very much in earnest. The American people have made up their minds to take possession of every market open to them, and hence it is not likely to be an unprofitable study if we seek to find out what they are doing, or have already done, that may affect our own mechanical industries.

The most important item in the list of American manufactured exports for a number of years past has been locomotive engines. The locomotive industry has assumed such large proportions in the United States that the home requirements, vast as they are, are totally insufficient to keep it employed. The number of locomotives exported from the United States has increased from year to year, until it is now between five and six times what it was six years ago. In other words, during that period the number of locomotives exported has increased from about fifty per annum to over three hundred. American locomotives are now annually exported to Russia, China, Japan, South and Central America, Canada, our Australasian Colonies, Cuba and other countries.

The amount of labor expended upon a locomotive engine is considerable, probably 75 per cent. of its total cost. Labor, however, is not a cheap commodity in the United States—certainly not cheaper, in nominal value, than in our own country. And yet the cost of building locomotive engines must be less in America than in Great Britain, or we should not witness a larger demand for American locomotives than for those built at home. The difference of cost must, moreover, be mainly a question of labor, for none of the materials of construction, on an average of the last ten years, have been cheaper on the other side of the Atlantic than on this side. Nor, when we speak of labor, do we necessarily mean that the American is a better or more hardworking artisan than the Englishman or Scotchman. It is not so much a matter of hard or intense labor as it is a matter of type. American locomotive builders, as a rule, adopt certain types, and stick to them. English builders, on the contrary, build a hundred different types to meet the fads of as many different locomotive engineers, many of them having the long purses of plethoric railways to draw upon, and caring little for economy so long as they can get their ideas tested to demonstrate the possibilities of special results.

Another point that greatly favors the American locomotive builder—and, indeed, the American manufacturer generally—is the fact that he not only sticks to particular types, which renders duplication easy and inexpensive, but he has a much larger and more steady market to rely on, and is, as a rule, more steadily employed than the British locomotive builder. This counts for much in reducing the heavy item of standing charges. The difference between one establishment working full time and another establishment working only half or three-quarters time is all the difference between making a profit and incurring a loss at a given schedule of prices. A further manifest advantage is gained by the American system of manufacturing on a large scale. Some of the American locomotive works—such, for example, as the Baldwin and the Schenectady—are, in point of size, far ahead of any similar works in this country, although we are prone to boast of such works as Neilson's, Dubs', Beyer & Peacock's, and the Kitson Works, at Leeds. We all know that if a factory is producing a thousand copies of the same thing it can do so much more economically than if it produced only fifty or a hundred, and herein, again, the works of the United States possess a notable advantage, alike in buying and in selling. Finally, in reference to locomotive engines, it has been claimed again and again that the American types are simpler, more powerful relatively to cost, and otherwise better than our own. We do not admit the truth of such claims, of course. Locomotive engineers of the first rank are continually debating this point, and it is still unsettled. But there must be those in all foreign countries that buy American locomotives who are disposed to prefer American types, or we should not see those types make the headway which they have done. The Baldwin Works alone have produced from first to last upward of sixteen thousand locomotives, and are represented in most of the civilized countries of the world. No locomotive works in Great Britain have, as yet, come anywhere near this record.

The observations which we have applied to the special conditions of American locomotive works apply, mutatis mutandis, to the manufacture of machine tools, of which the Americans now export four times the volume and value that they did ten years ago. During the last two years this branch of American export business has greatly advanced. This increase is largely attributed to the growth of the cycle industry in Europe, the American machine tools being imported for that class of work especially, although they are making headway in other directions. In one case fifty automatic screw machines by the Cleveland Machine Screw Company were ordered in one lot and to go into a single plant, and whereas in former years the trade consisted mostly of orders for single machines, or at most a very few machines in any one shop, it now often takes the form of complete equipments for the production of a certain machine or article. During the past year business is said to have been so good with them that they have been under no necessity of soliciting orders, but people have for the most part pressed to know how soon certain machines could be delivered. The growth of this business is the more annoying because, as a recent writer has pointed out, there is nothing in these tools which our native mechanics could not have produced if they had only thought of it. It is hard to account for this higher perfection of light machine tool making on the other side of the Atlantic. We are apt to consider that in a new country things are inclined to be haphazard and makeshift, but we must not forget that the engineering history of New England extends almost as far back as that of Old England. The earlier British engineers perfected the standard machine tools, and the engineering industry of the country has been so great that makers have not been forced into what are known as "special lines." When the heads of firms find they can make a good income by selling the same thing over and over again, they do not seek fresh combinations—unless, indeed, they have a natural love for designing. It may be that it is here that the New Englander has now the most considerable advantage. In the past many of our own machine tool makers were men who were brought up in the shops—mechanics, made into business men and heads of firms by the force of circumstances, but still mechanics. They had mastered their craft in the school of necessity, and loved it for its association with early days, and as a means by which they reached prosperity. They sent their sons to expensive schools, where the spirit of mechanical ingenuity has been an unknown thing, classics and the politer branches of learning being considered all important. The result is found in our failure to keep pace with those who have been trained in a sterner school.

One of the largest importers of American machine tools is Mr. Charles Churchill, who says he has encountered very little disposition or inclination in England to copy American machine designs. This may be due not only to the Englishman's inclination to have and to embody his own ideas in machine construction, but also to the fact that the prices at which American machine tools are sold in Great Britain discourage attempts to compete with the same machines, since it is readily seen that in order to produce similar machines at the same price a similar plant must usually be put down for manufacturing them, and with little hope of producing them at the same or lower cost.

For more than thirty years Mr. Churchill has been selling in England all sorts of drill and lathe chucks of American manufacture, yet, so far as he knows, there is not a single American chuck maker in England. American steel balls are also making headway, and orders for over twenty million American balls were placed there in 1896. It is believed that over two hundred Cleveland Machine Screw Company's automatic screw machines were installed in Great Britain last year. Another American product that seems to meet with a very favorable reception is the gas furnace of the American Gas Furnace Company, of which Mr. Churchill is agent.

Within the last few years the British have lost a large part of the industry of manufacturing steel tubing, of which we formerly exported large quantities to the United States. Colonel D. L. Cockley, vice-president and general manager of the Shelby Steel Tube Company, may be said to have founded this industry in the United States. In a chance conversation he learned that bicycle manufacturers were using an immense amount of steel tubing, all of which was imported. The two companies at this time in operation in England were the Weldless and Credenda. Two representatives of the Shelby Company were detailed on a special mission. It required persistent ingenuity to gain entrance to one of these steelworks. Disguised as a workman one of the representatives finally accomplished the task. Eventually, Hudson & Gay, tube drawers, allowed them to make sketches of their works and operations. The English preceptor of the tube industry declared that sizes less than three-eighths of an inch and larger than one and three-fourths inches could not be made; but at the works of the Shelby Tube Company, now the largest in the world, it is turned out in sizes ranging from one-eighth of an inch to as large as three inches in diameter, in gage from 1 to 30, English standard. The metal used is steel billets or blooms, imported from Sandviken, Sweden. Large annealing ovens, fed by gas, soften the tubes after each drawing, the final pulling giving the material the proper temper. Numberless slowly revolving hydraulic-like cogwheels, with endless chains of immense power, do the stretching of the steel tubes when cold.

So far as the miscellaneous exports of iron and steel products are concerned, the statistics of the ten years ending 1895 show a remarkable advance as set out in the table that follows:

EXPORT OF LEADING DESCRIPTIONS OF AMERICAN MANUFACTURES IN IRON AND STEEL, 1886 TO 1896.

Year.	Steel plates and sheets. 1=1,000 lb.	Steel rails. 1=1,000 tons.	Wire. 1=1,000 lb.	Bar Iron. 1=1,000 lb.	Steel ingots, etc. 1=1,000 lb.
1886.	9	4	8,036	1,519	272
1887.	564	2	9,612	2,131	134
1888.	119	5	12,734	1,508	207
1889.	57	7	16,420	1,549	506
1890.	484	9	21,529	2,087	369
1891.	145	16	25,000	2,400	597
1892.	243	8	26,059	2,854	966
1893.	654	15	42,798	2,768	664
1894.	1,305	16	44,778	6,681	1,145
1895.	2,119	10	61,093	7,801	6,975

Besides the above the United States export quantities of pig iron, band, hoop, and scroll iron, castings, car wheels, nails and spikes, saws and tools, stationary engines and boilers, and stoves and ranges. The unenumerated exports of iron and steel have increased from a value of over two and a quarter million dollars in 1885 to nearly seven and three-quarter million dollars in 1895. During 1896 still more notable progress has been made, and we are almost afraid to face the figures for the year 1897, which, as those published in the Review have already shown, has been making industrial history for the United States at a very rapid rate.—The Iron and Coal Trades Review.

BABBITT METALS.

By C. VICKERS.

"GENUINE" babbitt is composed of a small quantity of copper, added to tin and antimony. No lead is used, for the adjective "genuine" is applied especially to distinguish it from the cheaper grades containing lead.

There is considerable temptation to adulterate it with lead, owing to the difference in value of lead and tin; one pound of lead added to 100 of "genuine" makes a gain of about 18 cents. The character of the alloy would not be greatly altered, but when the purchaser pays for the best he certainly has a right to expect it. Fortunately, it is easy to detect such adulteration; take a piece and use it for a pencil; if it makes a mark, then it contains lead, as a small amount of lead added to tin causes the latter to mark paper. The following proportions may be used in making this alloy:

No. 1. Copper..... 4 lb.
Tin..... 8 "
Antimony..... 8 "

This forms the hardening, as it is called. First melt the copper, add the tin and afterward the antimony; remove from the fire and let cool down to a dull red heat, then add 16 pounds more tin to increase the fusibility of the hardening. This makes 32 pounds hardening, add this to 64 pounds more tin—the proportions of tin to hardening thus being two to one. The additional tin should be melted separately in a kettle or suitable vessel, and the hardening added either in ingot form or direct from the furnace; in the latter case be sure the tin is all melted, otherwise an accident might occur by the hot metal from the furnace falling on the damp end of a projecting ingot.

To prevent loss by oxidation, the contents of the kettle should not be heated much above the melting point. In cases where a cheaper composition is desirable, the following can be recommended:

No. 2. Genuine hardening..... 32 lb.
Tin..... 64 "
Lead..... 96 "

This forms a good alloy; another one is:

No. 3. Hardening..... 16 lb.
Tin..... 50 "
Antimony..... 20 "
Lead..... 80 "

In mixing this alloy, first melt a portion of the lead, say 40 pounds, in the kettle or in a crucible in the furnace, bring to a dull red heat, add the antimony, in small pieces, when melted add the balance of lead. Do not attempt to melt the antimony without the lead bath, as it is a volatile metal and there would be loss from oxidation.

In making all alloys containing hardening, a furnace is necessary, on account of the heat required to melt the copper. The following mixtures contain no copper, and are fairly good compositions:

No. 4. For hardening, take Lead..... 145 lb.
Tin..... 40 "
Antimony..... 20 "

Melt 145 pounds lead and 40 pounds tin and add 52 pounds hardening.

No. 5. For hardening, Lead..... 48 lb.
Antimony..... 26 "

Add this amount to 152 pounds lead. The hardening is used in this merely to form a bath for the antimony, and any portion of the 200 pounds lead may be taken. This is cheap and soft.

Another cheap composition is formed as follows, and is known as "hard lead:"

No. 6. Lead..... 80 lb.
Antimony..... 20 "

Hard lead is a better metal than No. 5. It is largely used for lining car journal bearings. It may be improved by the addition of tin as in the following:

Hard lead..... 100 lb.
Tin..... 100 "

This is given as an illustration. A great variety of alloys can be made by taking hard lead as a base and adding tin in varying quantities.

Zinc is sometimes added to cheap alloys. It has a tendency to form unsightly ingots, owing to the formation of bubbles on the surface. It should be kept out of strictly high class babbitt. It has been suggested that the addition of aluminum improves babbitt metals. But, while this may be true, the writer does not consider that the improvement will be sufficient to pay for the increase in cost. Bismuth is also sometimes used, but it possesses no advantage over antimony and is more expensive.

Before pouring into ingots, the dross which forms a scum on the surface of the liquid metal should be skimmed off and saved. The percentage of dross may be lessened by the use of a flux. Resin, tallow, or grease of any kind is a good flux for babbitt alloy. When any considerable amount of dross has accumulated, it may be melted by adding resin and small quantities of crude sal ammoniac. The flux must be thoroughly mixed into the pasty mass, until it liquefies, and the dross floats on the surface in the form of a greenish dust. It may then be skimmed off and the metal poured into ingots.—Machinery.

The damming of the Rio Grande River by an English corporation for irrigation purposes is objected to by the Mexican government, in a communication to the State Department of the United States, as seriously interfering with navigation, says the Engineering News. The proposed dam was to be located on the American side, at Elephant Butts, New Mexico, and authority for its construction was granted by the Secretary of the Interior, under the Desert Land Laws. Attorney General McKenna has now decided that the construction of the dam would injure persons along the Mexican side of the river, and would therefore be a violation of international law. He has, consequently, instituted civil and criminal proceedings to stop the work. The projected international dam at El Paso would also become useless if the Elephant Butts dam were erected, according to a report made to the War Department by Col. Anson Mills, U.S.A., and international boundary commissioner.

THE INTERNATIONAL GEOLOGICAL CONGRESS IN RUSSIA.

THE International Geological Congress may be said to come of age this year, for it was founded at Philadelphia in 1876, at a meeting held under the presidency of the veteran James Hall. The first organized session was held at Paris in 1878, and since then meetings have taken place at Bologna, Berlin, London, Washington, and Zürich. The seventh session is to be held at St. Petersburg, with Prof. A. Karpinsky as president.

The ordinary meetings of the congress will be held in the rooms of the Imperial Academy of Sciences at St. Petersburg. There will be a preliminary assembly of the members on August 28, the formal opening will take place on the following day, and the meeting will terminate on September 4. According to the Russian calendar, these dates will be twelve days earlier, namely, August 16, 17, and 23.

The meetings will extend over eight hours. From 9 till 10 a. m. the committees of the congress will deliberate; from 10 till 2 p. m. there will be discussions on questions proposed in the programme of the organizing committee. One hour is then set aside for visits to museums and to the exhibition of maps, sections, books, specimens and instruments—possibly some members may then take the opportunity of obtaining lunch. From 3 to 5 o'clock papers of a general character will be read, and these will be so arranged that only one branch of geological science will be discussed each day.

The organizing committee will reopen the subject of the unification of geological nomenclature. The larger divisions of the earth's history must be based on general paleontological characters, and in defining the several systems attention will be specially given to the study of pelagic life and the evidences of organic evolution. In order that a system be well established it must be capable of subdivision into stages characterized by well marked pelagic faunas, and these should have a European or equivalent value. It is recognized that substages have only a regional value, while minor divisions have but a local character, and with these the congress does not deal. The divisions, in short, which the assembly will be called upon to discuss are those of geological time, based on the occurrence of successive groups and zones of fossils; the purely stratigraphical divisions are essentially regional or local, and they may reasonably be left for each country to fix according to its own necessities; for they are all important in the interpretation of the structure of a district, in determining its economic resources, and in explaining the origin of its scenery. On the other hand, when we seek to trace out the history of the great changes which the earth at large has undergone, the more comprehensive life divisions are all important; and these only can be universally applied, and, we hope, universally adopted. It is true that life divisions are no more to be rigidly defined than are stratigraphical divisions in the rocks, but fossils are the only guides for correlating the formations in countries far apart. There should be no serious disagreement among geologists, at any rate with regard to the principles of correlation; and there is no reason why, after full and friendly discussion, a particular nomenclature should not be generally accepted. It need not interfere with our local divisions, any more than great chronological terms, if applied to human history in general, would interfere with our own time divisions marked by the reigns of successive monarchs.

The organizing committee will also deal with the subject of petrographic nomenclature, in the hope of reducing the number of terms now used, and of preventing unnecessary names being introduced. In petrology, as in paleontology, one is nowadays in constant need of a dictionary or glossary, or table of synonyms, to understand the various names of rocks or rock structures and fossils.

The scheme for excursions in connection with the congress is an elaborate one. There will be excursions both before and after the ordinary meeting, and those who have time and money will have grand opportunities of visiting many parts of the Russian empire in Europe.

Prior to the congress there will be three excursions; namely, to the Ural regions, to Esthonia, and to Finland. The Ural excursion is timed to take place between July 28 and August 27. There will be a general gathering of the party at Moscow on July 29, and those who join are advised to take thick boots, warm clothing, and waterproof cloaks, for there will be rough walking as well as long journeys in open carriages and on horseback. Messrs. Nikitin, Tschornyschew, Arzruni, Karpinsky, and Stuckenberg will act as leaders. The party will take train to Riazan, and thence journeying to Syzran, on the Volga, they will cross Jurassic, Cretaceous, and Tertiary strata. Thence from Samara to Oufa, Permian and Triassic rocks will be traversed, while onward to the Ural Mountains the party will pass over Carboniferous, Devonian, and Silufo-Cambrian strata, which present evidences of considerable metamorphism, and which, together with various schists, are penetrated by numerous eruptive rocks. The region is famed for its metalliferous deposits, and various mines in rocks bearing gold, copper, and manganese will be visited, as also will be the imperial stone-cutting works at Ekatherinebourg. The return journey will be made by Perm, Kazan, and Nijni-Novgorod.

The excursion into Esthonia, August 13 to 27, under the direction of M. Schmidt, will be by rail to Reval, on the Gulf of Finland, and then a visit will be paid to the Isle of Dago, when attention will be given to the fossiliferous Upper and Lower Silurian rocks.

The excursion to Finland will be made under the guidance of M. W. Ramsay. The members will assemble at Helsingfors on August 21, and return to St. Petersburg on August 28. Tammerfors and Lavia will be reached, and attention will be directed to the glacial phenomena and the various crystalline rocks.

After the meeting of the congress is over, the principal excursion will be to the Caucasus, leaving St. Petersburg on September 5, and arriving at Moscow on the following day. The excursion party will then be divided into three sections, A, B, and C. Section A will be conducted by Messrs. Nikitin, Gourow, Tschernyschew, Loutougin, Rouguéwitsch, and Konchin. Leaving Moscow, and traveling by Podolsk, the route will be over Jurassic, Carboniferous and Devonian rocks, and on the Cretaceous strata of Koursk and Kharkow. Thence the party will proceed to Rostow, at the head of the Sea of Azov, examining a mercury mine and certain mineral springs, and ultimately reaching Wladikavkaz, on the northern side of the Caucasus Mountains. Section B will start, under the guidance of Messrs. Pavlow and Amalitzky, from Moscow to Nijni-Novgorod, across Jurassic and Triassic formations to the Cretaceous rocks of Simbirsk on the Volga. Journeying southward, they will visit asphalt quarries, and by means of steamer and railway they will proceed along the plains of the Volga and the borders of the Kirghiz Steppes to Astrakhan and Wladikavkaz. Section C will be under the direction of M. Sokolow, and will journey to Kiew, on the Dnieper, paying especial attention to the Tertiary and Post-Tertiary deposits. Following the river to Alexandrovsk, the party will ultimately join the two other sections at Wladikavkaz by way of Rostow

Thus united, the whole party will proceed across the mountainous country to Tiflis, under the direction of M. Loewinson-Lessing, some few members separating for a while to examine a glacier under the guidance of M. Kolenko. Tertiary, Cretaceous, Jurassic, and metamorphic rocks will be seen. From Tiflis all will proceed to Baku, on the borders of the Caspian, and thence separating into two portions, they will traverse the mountainous region from east to west, and unite again at Rion. Some may spend a week in the Caucasus, examining the Mamisson glacier; others will have an opportunity of visiting Mount Ararat.

Those who desire to still further continue their field studies among Cretaceous and Jurassic rocks may take part in a general excursion into the Crimea. They will proceed by steamer from Batoum to Kertch, and eventually, on October 5, there will be a reunion of all the remaining excursionists at Sébastopol. Thus will terminate the great programme of expeditions planned by the geologists of Russia.—H. B. W., in Nature.

THE BAKERIAN LECTURE—ON THE MECHANICAL EQUIVALENT OF HEAT.*

THE purpose of this research differs essentially from that of any previous research on the mechanical equivalent of heat. In order to diminish the loss of heat by radiation, as well as to obtain the equivalent for water in the neighborhood of ordinary temperatures, the ranges of temperature over which the previous dynamical measurements have been made are greatly less than the standard interval between the physically fixed points of temperature to which all thermal measures are referred, and so have of necessity involved the use of scales, the intervals of which depend on the constancy of the relative expansions of such substances as glass, mercury, and air. On the other hand, in this research the object has been to determine the mechanical equivalent of the total heat necessary to raise the temperature of water over the standard interval of temperature, and thus to obtain directly the equivalent of the mean specific heat between the freezing and boiling points.

This undertaking is the result of the occurrence of circumstances which afforded an opportunity such as might not again occur. This consisted in the facilities offered by the appliances which formed the original equipment of the Whitworth Engineering Laboratory, in 1888, the more essential of these being an engine of 100 H. P., working one of Prof. Reynolds' hydraulic brakes. This brake maintains any constant moment of resistance on the engine shaft, independent of the speed, all the work done being converted into heat, which appears in the rise of temperature of a steady stream of water flowing through the brake, the magnitude of which stream is independent of the load on the brake or the speed of the engine, and is under independent control.

The existence of the Manchester town's water, of a purity expressed by 3 grains of salts to the gallon, conveniently distributed in the laboratory, as well as auxiliary power, both steam and water.

Although unconsciously, the research was really commenced in 1899, when, without any intention of making a determination of the heat equivalent of the work done on the brake, but solely for the purpose of verifying the mechanical balance of the brake, provision for thermal measurements was added, and a system of trial instituted, in which the object sought was only that of obtaining consistent results over definite portions of the scales of uncorrected thermometers, eliminating the errors resulting from radiation by taking the differences of two trials. In these trials the temperature ranged from 40° to 50° F., and their development was continued over two years. Then it occurred to Prof. Reynolds that by the same method the great facility which this brake was then seen to afford would be available for the independent determination of the mechanical equivalent, if it could be arranged that water should enter the brake at the temperature of melting ice and leave it at that of water boiling under the standard pressure. Since then all that would be required of the thermometers would be the identification of these temperatures, and with a range of 180° the error in scale over one or two degrees would be comparatively of small importance. At first the difficulties seemed formidable; but on trying by gradually diminishing the supply of water to the brake when it was absorbing 60 H. P., and finding that it ran steadily under control of its automatic gear till the temperature was within three or four degrees of boiling, he further considered the matter, and during the next two years convinced himself of the practicability of the necessary additional appliances by preliminary designs. These consisted of:

(1) An artificial atmosphere or means of maintaining a steady air pressure of ½ atmosphere in the air passages of the brake.

(2) A circulating pump and water cooler, by which the entering water, some thirty pounds a minute, could be forced through the cooler into the brake at a temperature of 32°, having been cooled by ice from the temperature of the town's main.

(3) A condenser by which the water leaving the brake at 212° might be cooled down to atmospheric temperature before being discharged into the atmosphere and weighed.

(4) Such alteration in the manner of supporting the brake on the shaft as would prevent excess of leakage from the bushes in consequence of the greater pressure of air in the brake, since not only would the leaks be increased, but, when the rise of temperature was increased to 180°, the quantity for any power would be diminished to one-sixth of that for a rise of 30°, so that any leakage would become six times the relative importance.

(5) Some means by which assurance of the elimination of the radiation and conduction could be obtained, as with a temperature of 140° F. above the laboratory these would probably amount to 2 or 3 per cent. of the total heat.

(6) Scales for greater facility and accuracy in weighing the water with a switch actuated by the counter.

(7) A pressure gage or barometer by which the standard for the boiling points might be readily determined at 3° or 4° F. above and below the boiling point, so as to admit of ready and frequent correction of the thermometers used for identifying the temperature of the effluent water.

(8) Some means of determining the terminal differences of temperature and quantities of water in the brake, which would be relatively six times as large as with 30° rise.

These preliminary designs apparently demonstrated the practicability of the appliances, and also the possibility of their inclusion in the already much occupied space adjacent to the brake. But there remains still much to be done in the way of experimental investigation in order to obtain the data for proportioning the appliances.

In July, 1894, Mr. Moorby having undertaken to devote himself to the research, the experiments necessary for the appliances were at once commenced, and these, together with the construction of the appliances and then standardizing, and preliminary experiments while this was in progress, occupied till February, 1896, when Mr. Moorby commenced the main experiments, which were continued into July, 1896.

In these experiments the time of running was 62 minutes, the speed 300 revolutions a minute, on the speed gages. Observations of speeds, of the temperature of the inflowing and effluent water, and of the temperature of the air were made every two minutes. Observations of the slope of the temperature of the shaft were made every eight minutes.

The temperature of the inflowing water varied from 32·5° to 34°, and that of the effluent from 210° to 214° F. The effluent water was cooled to 8·5° before entering the tank, on the scales in which it was weighed, weighings being taken before and after each trial.

The temperature of the metal surface of the brake being sensibly the same as that of the effluent water (212°), and by taking the difference in the work absorbed in two trials and the differences in the heats developed, the errors of radiation and balance in the brake were approximately eliminated, and in order to complete the elimination the coefficient of radiation was approximately determined, so that a correction might be applied for any residual differences of temperature as observed, and in the same way with the slope of temperatures. Further assurance was also obtained by making some trials with the brake naked and others with it covered, so as to reduce the loss of heat to one-fifth; and, in the same way with every circumstance which could affect the result trials, means were taken to vary the circumstances in different series of trials, so as to obtain an estimate of the limits of error. All the appliances were most carefully standardized; and taking all the limits of error into account, the limit of the sum was less than 0·0003.

In all fifty-two trials were included in the final result. Of these

25	with loads on the brake of	1,200	ft. lb. at	70	H. P.
21	"	"	600	"	35	"
6	"	"	400	"	23	"

From these, twenty-five separate determinations were made of the equivalent subject to certain general corrections given below, which gave a mean value 777·91, and from this none of the separate determinations differed by as much as 0·2 per cent., which arranged in eight groups, according to the circumstances under which they were made, the greatest divergence from the mean was 0·05 per cent.

It was found impracticable to eliminate entirely from each determination the losses of heat due to radiation, conduction, leakage of water, etc., and so it was found advisable to determine what these losses were. This information was given by the trials themselves, and the necessary corrections were applied to each separate determination. As illustrating the extent to which the method adopted did eliminate these errors, it is interesting to remark that on the mean value of the equivalent determined, without taking these errors into account, the error was only 0·0192 per cent.

Certain final corrections, which had the same values for all trials, were made to the mean value of J, already given. These were introduced on the following various counts:

I. Length of the brake lever (0·00042).
II. Salts dissolved in Manchester water (0·00003).
III. Air dissolved in water used in the trials (−0·00021).
IV. Reduction of weighings to vacuo (−0·00120).
V. Varying specific heat of water (−0·00006).
VI. Pressure on thermometer bulbs (−0·00037).
VII. Work done against gravity (0·00007).
VIII. Engagement of counter (0·00001).

Their total effect was to introduce a correction factor (1−0·00125).

The mean corrected value of the specific heat of water between freezing and boiling points, as measured in mechanical units at Manchester, is found to be 776·94.

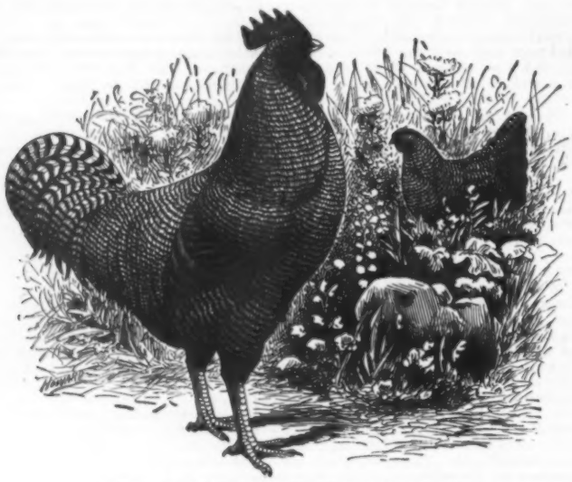
* By Prof. Osborne Reynolds, F.R.S., and W. H. Moorby. Read before the Royal Society, May 20. —Abstract from Nature.

A great boom in autocars is promised in Paris by next spring, the Exhibition year, 1900, being too far off to wait. A company promises to have at least 500 autocars on the streets of Paris by the end of the present year, and about 4,000 before next summer. It is stated that they will be worked by electricity stored in accumulators and the name "chauffeurs" has already been found for the drivers. One translation of that term is "bandits who burned people."

THE STANDARD VARIETIES OF CHICKENS.

By JOHN MICHELS.*

ONE of the most interesting, and, no doubt, will prove the most popular bulletin issued for farmers by the United States Department of Agriculture, is that relating to the standard varieties of chickens in this country, of which there are eighty-seven, besides a large number of promiscuous varieties.

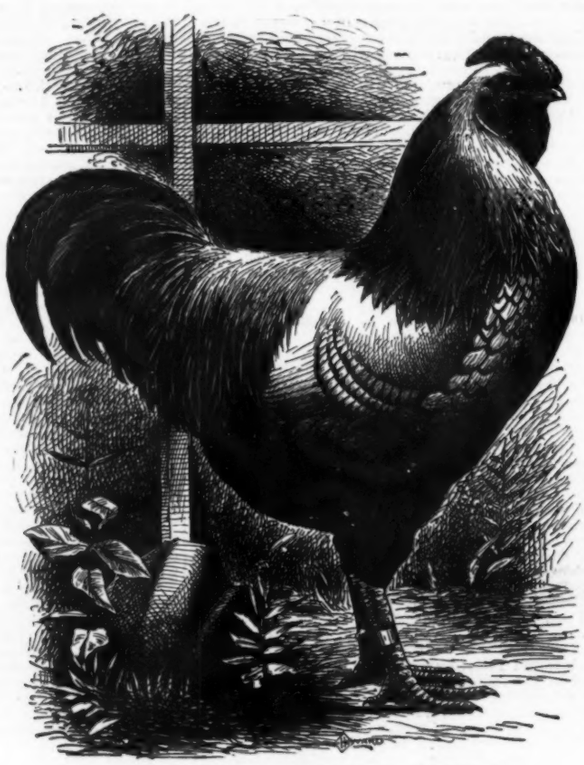


PAIR OF BARRED PLYMOUTH ROCKS.

FEATHERS OF BARRED PLYMOUTH ROCKS.

Perhaps the most popular of the varieties, and the best to keep for general purposes, is the barred Plymouth Rock. It is of a grayish white color, regularly crossed with parallel bars of blue black running in straight, distinct lines throughout the entire length of feather. They are hardy, good layers, averaging eight to a pound. This is a practical bird and good for the market, and, at the same time, the most sought after by the fanciers. Some of this variety has pure white plumage.

Next in popularity come the Wyandottes, as they have proved a great success. They were raised from the dark Brahmas, silver-spangled Hamburg and the French fowl Bredas. As their ancestors had feathers on their legs, it would seem to indicate they have Cochin blood in them. They weigh about a pound less than the Plymouth Rock, and are prolific layers, as they generally yield about fourteen dozen eggs a year. There are five varieties, and it is only a matter of taste which is the best. In color some are silver laced, others golden, buff, black, and some white. The average weight, when full grown, is 8½ pounds. The feathers are beautifully marked.



SILVER-LACED WYANDOTTE COCKEREL.

As a contrast to other poultry the tall, commanding figure of the Exhibition Game Cock is remarkable. For a long time Exhibition Games have been a favorite fowl in this country. By careful breeding for many generations, they have been brought to a high state of perfection. Their beauty is much praised, and their class is always well filled at the numerous shows. It should, however, not be thought that they are unprofitable fowls to keep, but are good for farm purposes. They are, as a class, splendid layers, excellent table fowls and good sitters and mothers.

We now come to the Cochins, of which there are four classes, of which the buff is most bred and popular. Some are pure white, others pure black. The feathering of the legs, feet and even toes is the well known characteristic of this variety, which gives it a rather grotesque appearance; but fanciers consider them very beautiful. They are hardy, good winter layers, but only fairly good table fowls.

This remarkable bird is one of the oldest varieties of poultry. Its ancestors can be traced back to the sixteenth century. They are a medium sized fowl, and the leading characteristic is, of course, the crest, which is composed of yellow feathers, and should rise well up in front, so as not to obstruct the sight, and fall over the back and sides in a flowing, even mass. The smaller the comb the better, and, if wholly removed, it is not considered a disqualification.

The Leghorns are the best known of the egg-producing varieties of the Mediterranean class. The Leghorn hold the same place among poultry that the Jersey hold among cattle. They are lively, active and the best of foragers, and will pick up a great part of their living during the year. They are the best layers, averaging 150 to 200 eggs a year. The eggs are pure white, and weigh about ten to a pound. Altogether, they are the most profitable breeds that can be kept on a farm, the cheapness of their keep allowing the raising of two Leghorns for the cost of one Asiatic. In shape they are graceful, body round and plump, broad at the shoulders and tapering toward the tail.

The Sultans are a recent exportation from Turkey. They were introduced into England in 1854, but reached America several years later. Considering their characteristics, they might be classed as Polish, but their feet are feathered and they have a fifth toe. Their beauty is their chief recommendation, as they lay claim to modest usefulness only as layers, for they are too small for table use.

The Japanese bantam is white and is noted for the

RED PYLE GAME COCK.

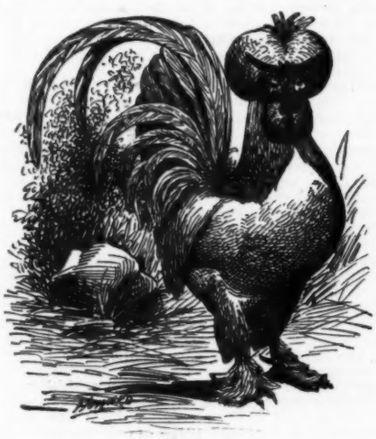
SILVER DUCKWING GAME COCKEREL.

FEATHERS OF SILVER-LACED WYANDOTTE.

* Late of the United States Department of Agriculture.

beauty of the tail, as well as for the graceful shape of the neck and breast.

Yokohama sends us this remarkable variety of fowl. The tail is about a yard in length. The Phœnix fowl is one of the myths of the Japanese religion, and is often seen in Japanese pictures. The Bulletin, from



SULTAN COCK.

which our pictures are taken, was prepared by Mr. George E. Howard, secretary of the National Poultry Association, under supervision of Dr. D. E. Salmon.

THE THEATER OF INSECTS.*

THE first zoological book printed in England was the "Theater of Insects," by Moufet in 1634. The title of the book would suggest that the author, after the manner of old Izaak Walton, was wont to moralize a bit over his studies of natural history. We fancy that he

BLACK-TAILED JAPANESE BANTAM COCK.

saw, as upon the stage, both tragedy and comedy in the lives and ways of the little known insect world.

The theater of insects differs from all other theaters in that its busy season comes during the summer months. Just as in the long ago, historical geology tells us that flowers and insects appeared in the world at the same period of time, so now in early spring the blooming of the first flowers announces the awakening of insect life. If during the last week of the month of May you visit a cold, damp woodland of Northern New England, your attention will at once be arrested by

BACK VIEW OF BUFF COCHIN COCK, SHOWING FULL FEATHERING.

the handsome and conspicuous blossoms of the hobble bush, or wayfaring tree. The large flower buds are formed the previous season, pass the winter wholly naked and open in spring with the appearance of the leaves.

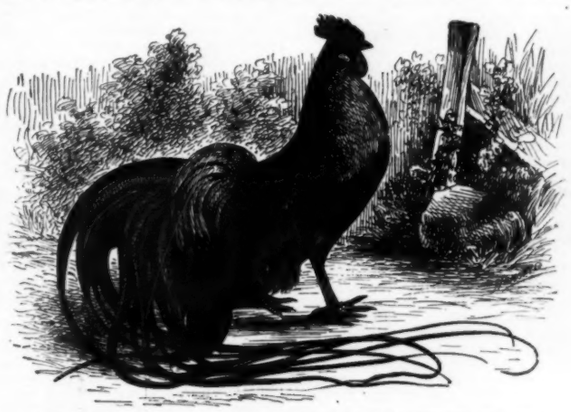
This shrub may be easily recognized by its straggling habit of growth, its drooping branches and the broad flat heads, or corymbs, of flowers of two different sizes. The center florets are small, greenish in color, and in autumn produce bright red berries; while the marginal ones, a single row of which surrounds the corymb, are large, white, and sterile. Their size has been increased at the expense of their power of producing seed, and as their use is to attract the attention of insects, they usually open some days in advance of the inner and smaller florets. But for them, the blossom would easily pass unnoticed amid the budding foliage, as may be easily proved by cutting them off. Since their conspicuousness is useless to themselves but of benefit to the community, they may be said to unconsciously play the part of benefactors.

A sort of barter or exchange is carried on between the flowers of the hobble bush and the insects, by which each is of service to the other. A small quantity of honey, in a thin layer, is secreted by the inner florets, and as insects pass quickly from floret to floret in search of this, their bodies become covered with pollen, and they repay the plant for the food they obtain by effecting cross fertilization. Let us carefully watch the flower on a sunny day and observe how successful it is in attracting insect visitors. I have taken upon it and have now in my collection three species of bees, one butterfly, a small brown species of miller, three hemiptera, five flies and seven beetles, or twenty species in all, a large number for the month of May. Butterflies are rarely met with, for as the honey is fully exposed and not concealed in a deep pit, as in the pinks, the flowers are adapted only to the visits of short-lipped insects such as flies and beetles. Upon the open flowers they can readily obtain both honey and pollen, and in consequence are the most frequent visitors.

In gathering honey from the flowers of the hobble bush there would seem to be no possible danger to insects, and yet they not unfrequently meet with a tragic end. Here lying upon the flat top of the blossom is a dead fly. Lift it up and you will discover how it was killed. The head is firmly grasped by the mandibles of a white spider, which, rather than release its prey, permits itself to be dragged from its hiding place and deposited in your collecting box.

Except for a red lateral stripe on the abdomen, its color closely resembles that of the flowers amid which it lives, and of whose power of attracting insects it has learned to make use for its own benefit. I have never been able to observe this spider in the act of seizing insects, but I believe it catches them while they are sucking honey. A member of this same family of spiders also frequents the pyramidal flower clusters of the hard hack, and I have known of its capturing so large and strong an insect as the hive bee.

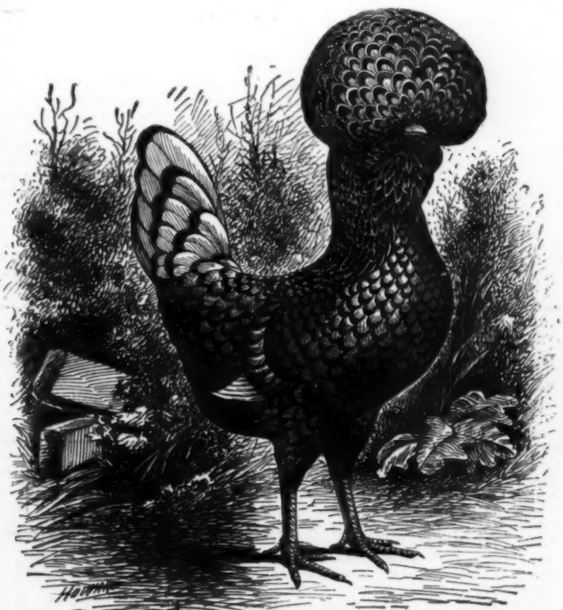
Bees puncture the two-lipped tubular flowers of the common skullcap (Scutellaria galericulata). In two instances a narrow slit was observed on the upper side of the curved corolla tube, and in a third case the whole upper portion of the tube was cut away, leaving the lips suspended by a mere thread. The buds while still quite immature are also punctured at the apex, usually on the under side. The piercing of nearly mature buds has been recorded of Lamium album, but never before, so far as known to the writer, of the skull-



LONG-TAILED JAPANESE GAME, OR PHŒNIX COCK.

* John H. Lovell, in Popular Science News.

SINGLE-COMB BROWN LEGHORN COCK.



BEARDED SILVER POLISH HEN.

cap. The perforation of the flowers of the Labiatæ by bees is, however, of common occurrence. Both the maxillæ and mandibles appear to be employed, the former for piercing and the latter for biting away the tissue, and both the bumble and hive bees are known to make use of the holes in extracting honey.

If, after the manner of certain plants famous in myth and story, the Impatiens (fifty, in this respect, named Touch-me-not) could speak, what a protest it would utter! For unknown centuries it has been developing the color and form of its flowers only at last to find its work in danger of being rendered worse than useless by a change in the habits of its bee visitors. It should, however, be mentioned that the flowers in North America are visited by humming birds, and I have also seen another smaller species of bee enter the flower in search of pollen.

COLOR IN ANIMALS—ITS CAUSES AND USES.*

ANIMAL coloration is either structural or useful. The brilliant colors of some of the minnows are of no actual use to the minnows, but due to some structural peculiarities.

Useful colors are such, for example, as cause an animal to resemble its surroundings—escaping its enemies or enabling it better to creep upon its prey.

An object through which light passes practically without absorption is transparent. Reduce or comminute that object to such condition that large quantities of light are reflected, it becomes white. A transparent piece of glass or ice, pounded into powder, looks perfectly white. The light is dispersed and disseminated in such a way that it no longer passes through, and we get the effect called white. Snow pressed into a solid block becomes transparent. We get glacial ice through the enormous pressure of snows accumulated year after year, that at the bottom of the glacier appears as pure, transparent ice. The binding oil globules in the cream break up the light, and we see the milk as white. Water it, and it turns bluish—more or less transparent.

In the white hair of the head we have the transparent shaft, and under the microscope this shaft air always appears black, though the effect to the naked eye is white.

History tells us of human hair turning white in the night. Long ago this was assigned to some acid secretion in the head arising through some tremendous nervous strain. This is wrong. It is probably due to the blood at the base of the hair forcing up air bubbles through the shaft, this producing disseminated light and the effect of white hair.

This power of changing the coloration of the hair can be utilized in a great many cases, as we find in Arctic animals, for a color protection.

Among structural colors we have the iridescence so commonly distributed through nature. The iridescence of the soap bubble arises from the fact that the bubble being very thin, some light is reflected from the outside of the bubble and some from the inside.

A microscopic examination shows the mother-of-pearl shell to be made up of very fine lines so closely put together that the white light is broken up into its prismatic colors, and we get the so-called "play of colors" or mother-of-pearl. Taking a very careful cast of mother-of-pearl shell with very fine lines, the wax will yield the same iridescence as the mother-of-pearl.

Some birds' feathers owe their color to this same cause—as in the iridescent spots on the peacock and the iridescent green color of the trochilus.

The casting of the skin in the case of the snakes is done entire; in the case of other animals, in large flakes or parts of the skin. In the reptilian casting the new and the old skins are separated by a very fine layer of hairs called "casting hairs," that seem to push up the outer skin while the lower one is forming, separating them so that the old will slide off when the process is ready to be executed.

The crabs in casting their shells exhibit the same curious arrangement of casting hairs which under the microscope appear as really worn off; but it is the lines of the bases of these hairs (which are arranged in rows) that in the reptiles break up the light as in the mother-of-pearl and give us the scale. In some cases these casting hairs have been retained in the animal and applied to a totally different object.

The gecko has curiously lobed feet cut up into ridges and each one covered over with microscopic hairs. It is an arrangement that serves as a sucker and is quite common in the animal kingdom. The fish that attaches itself to the shark has the same principle—a series of slats like a Venetian blind that will pull up and cause suction on the object to which it is applied; and these little casting hairs are of great value in holding the feet flat on objects, also to release the feet when it is necessary to let go. These little geckos are thus enabled to crawl all over ceilings and smooth, vertical rocks. They are common at Villa Franca, in the West Indies, and throughout the tropics generally.

The young gecko cannot hold on to upright surfaces until it has shed its first skin, prior to which shedding the casting hairs are lacking.

In a number of cases biliary salts are deposited in the skin of the animal for the production of the distinctive color.

An interesting change of color is going on in the Caucasian race. Russians, Danes, Norwegians and other northern tribes are characterized by light hair and blue eyes; while along the Mediterranean shores and in Southern Asia people have dark eyes. All the light races are gradually going out of existence; that is to say, there is a tendency for the Caucasian race to become dark, and this is probably based on the action of the liver. A northerner living in the tropics tends to torpidity of the liver; the biliary salts are not properly eliminated from the body and commence to be deposited under the skin. On the other hand, in cold climates, the liver is very active and the biliary salts are carried off and not deposited in the skin, hair and eyes; so we have the light, long hair and blue eyes.

Civilized races are producing a tropical climate throughout the year, and even when living in the extreme north live in a temperature of 70 to 80 degrees all the year round. This acts upon the liver, and the liver upon the skin; and these modern conditions are gradually driving out of existence the light haired and blue eyed races.

Some animals change their color at will. The color itself is always there; but by contracting certain of these pigment cells, and allowing others to expand, a temporary change can be effected. The chromatophores from the skin of a frog represent pigment cells. Some contracted and some expanded in different degrees of expansion will grade the animal in color, making it at times dull brown, at others green.

In the case of the chameleon, the chromatophores are supplied with actual muscles, giving them much more powerful and quick control over their color than most other animals. The chameleon can change to the brown of the bark or to the dark green of the leaves of the tree upon which it lives; but in those stories making the chameleon scarlet on occasion the writers have drawn upon their imaginations; because we know the animal could not produce scarlet.

The cuttlefish has the chromatophores very highly developed. Get hold of one of these or a squib on the sea coast before it dies. You can hardly see the spots upon it, some being as large as, others larger than, a pinhead. Irritate the animal, and you will find the spots closing up. It will become pale instantly, almost as soon as your pencil touches the animal.

The sole of the English coast, when placed upon a gravelly bottom, assumes the color of the bottom to a remarkable degree, this being a case of color protection whereby the animal has the power of making itself in exact harmony with its surroundings. Place the sole in an aquarium with light yellow sand, it would turn just that color; as I have often seen in the aquaria at Woods Holl. Take this same individual sole out of the aquarium and put him on a white porcelain plate, the chromatophores will contract down to the very utmost limit and make the animal almost white. The sole's under surface, of course, is always white.

A sole was found to be entirely out of harmony with the bottom over which it lived. Its color would be light when placed on a dark bottom, and dark when changed over a light bottom; and it was found later the animal was blind and there was no correlation between the surroundings and the chromatophores. Other specimens have been blindfolded and proof afforded that the harmonization was guided entirely by the animal's own eyesight.

Color has reference to the general color of an animal, while coloration means the pattern of color upon the animal, as striped or barred. The proteus has lost all the pigment of the skin, and it being transparent, the blood of the animal shines through and gives it a beautiful pink color—in this case a non-significant color.

In excitement, the wattles around the head and neck of the turkey become deep scarlet, due to the rush of blood to these parts, and gives it one of the sexual colors. The blushing on our own faces is due to some nervous emotion, producing partial paralysis of the muscles controlling the caliber of the capillaries, and these, being relieved of compression, becoming enlarged, an excessive flow of blood, with high color, results.

The polar fox has two general colors—white in winter and dark in summer—both very important to the animal. Formerly it was considered this was due to the fact that dark colors part more easily with their heat than do light colors; therefore, the animals dark in color would get rid of their heat; while in the winter the white acted as a non-conductor of heat, thus retaining it within the animal's body. This theory is now abandoned. The change of color is due to the action of environment, and probably is due not entirely to the action of cold.

The dark summer coat of the polar fox is in general harmony with the ground of the rocky Arctic regions where the sun has melted off the snow; the same thing when the animal becomes white and runs over the snow, when it is almost impossible to see it.

The lemming is a rodent common throughout northern Europe, Asia and North America. In Sir John Ross' northern expedition he kept a lemming in the cabin for a long time in winter. The animal retained its summer pelt of dark brown color in harmony with the rocks upon which it lived. In February he placed it in a cage on deck thirty degrees below zero. Next morning its cheeks and shoulders were patched with white, and at the end of the week it was nearly all white. The hair itself had actually turned white, and I suppose there was no reason to doubt the fact that it was due to the forcing in of air bubbles through the shafts of the hair, breaking up the light. Later on a growth of white hair came out from below, gradually replacing the hair that had been changed so suddenly. The cold of the winter really produced this white hair for the protection of the skin.

The ptarmigan displays this dual coloring, being snow white in winter and almost indistinguishable in the snow, while the summer-plumaged ptarmigan can be within two or three feet of the hunter and invisible. The male is quite conspicuous, but he is very shy and keeps away from his enemies. I remember gunning once in Greenland when some of these ptarmigans were located, and, after waiting awhile for a shot, we finally fired at the group, when right around us, within six feet, six of them flew up, unnoticed before because of the perfect harmony of their coloration with the ground. In watching those we were going to shoot, it was sometimes difficult to see them actually, but as soon as they were shot the white feathers underneath were thrown up and they were then very conspicuous on these dark rocks. These were cases of protective coloration.

The caddis worm, the larva of the dragon fly, abundant in the waters of our parks, wraps itself in tubes made out of particles of sand; so that while it crawls around on the sandy bottom we cannot see it.

The crabs will do that, and not fasten the substances to their shells always, but will actually put them on. The common spider crab of our coasts has its outer covering rough and covered with peculiar hairy hooks and spines; and the animal will put seaweeds upon itself. If one found covered with green seaweed be placed in an aquarium with reddish-brown seaweed, it will strip itself of the green and put on the brown, so as to harmonize itself with its surroundings.

Amplinarius—a fish common in the Sargasso Sea—is in actual color brown, resembling gulfweed, and spotted, and has peculiar long tentacles or filaments running off from the body, which resemble the filaments peculiar to the gulfweed. It is one of the most beautiful cases of mimicry in color and form that we know of among fishes.

We find color mimicry even among snails; one species in Cuba affording a great variety of blues, reds, blacks and greens, more or less arboreal, living upon different colored fruits, as yellow or red bananas or pommes de terre—upon green fruits and green leaves. In all there is a thorny, hairylike substance on the outside of the shell which accumulates mud; so that the animal looks like a little ball of mud and is very inconspicuous when first detected.

As a rule, arboreal snails are green. The green ones among the Philippine Islands are arboreal right straight through, and resemble the foliage upon which they live.

Some snails, not being protected in other ways, have another curious form of protection, namely, teeth in the mouth of the shells. Mr. Pilsbry, of the academy, has concluded that these teeth are for the purpose of keeping out carnivorous enemies.

There are snails actually resembling thorns. This variety remained for a long time undiscovered until someone, carefully examining some of the bushes, noticed the fellows walking around upon the branches.

Animals, again, will have some part of the body that they can well spare brilliantly colored for the attraction of some enemy; this part, when grasped, being readily detached from the body, and, while losing the part, the sufferer escapes with its life.

A certain snail has upon the end of its tail a bright red spot, which comes off almost on touching it. A bird seeing this will seize the only object it sees, because the animal will be on a green leaf; the snail will part with this brilliant piece of coloring and drop to the ground and thus save its life. One authority in taking a large number of these snails found ten per cent. had lost their tails in this way to their enemies.

Lizards likewise lose their tails to their enemies and thus save their alter ego.

The squirrel has a very conspicuous tail. The Germans have dubbed the animal Eichhoernchen, "the little horn on the oak tree." A squirrel on the run has its tail spread out behind it. An enemy seizing this will get nothing but a bunch of hair, the skin at the tip of the tail coming off very easily with its tuft of hair, leaving the main brush still in the possession of the animal.

Another peculiar coloration among animals but recently pointed out by Wallace is the so-called warning colors. New examples are coming to light almost daily. One of the most conspicuous examples is the skunk, Mephitis Americana, than which probably there is no other animal on the American continent more conspicuous, and none to which we would more readily yield a clear coast. A peculiar secretion that can be voided by this animal is intensely offensive, but as long as the animal is left alone this is not put into operation. The animal is very conspicuous in the dark; and with its jet black underneath portion and its bright bands of white, it carries a signal flag to keep out of the way.

The tree toads, living on leaves, are green in color; while those living upon the ground are dull, like the clay and dirt of their habitat. In the tropics, tree frogs and ground frogs are nocturnal, almost without exception, and all of them have protective coloration.

There is a little diurnal frog, that leaps about perfectly fearlessly through the tropical woods, with brilliant blue coat and crimson breeches; and he is there in large numbers. His devourers are lizards and birds. A naturalist brought some home to his garden, and tried to feed them to his ducks, which would not have anything to do with them. Some pieces of meat, the size of these frogs, were fed by hand to the ducks, and, during the operation, a frog was substituted for the meat, and the exotic frog thus introduced into the mouth of the duck, which ran around the yard shaking his head as though he had received some very disagreeable acrid dose from the animal.

Some of the snails are extremely conspicuous on certain rocks. Voyagers down the Riviera have noticed a pure white snail attached to the rocks. A snail collector in Central America, having to use both hands in climbing the rocks whereon rested a conspicuously colored group of snails, seized the snails in his mouth, but could not keep them there. They were so very bitter and caustic he was obliged to throw them out. Most snails can be retained in the mouth without disagreeable consequences; but these snails upon the rocks undoubtedly protect themselves against their enemies, the birds, by a flavor they cannot stomach.

Since the creation there has been ceaseless activity among the carnivores and herbivores—among the former, to eat the latter; among the latter, to get out of the way. We have developed in the carnivores craft and strength; in the herbivores speed, as in the zebra.

There is nothing in the world more conspicuous than a zebra. And yet Baldwin, one of the most trustworthy naturalists, says that in his travels in Africa, on bright, starlight nights, the zebras would come so near that he could hear them breathing and yet could not see them. If the zebra's bands were any broader, it would appear as a black mass; and if any lighter, as a light mass. As it was, so did they harmonize with their surroundings it was impossible to locate them.

Cummings, in his travels in Africa, speaks of the giraffe, an animal almost as conspicuous as the zebra. Giraffes seen in the zoological gardens, back of grates, with ugly bars around them, stand out very conspicuously; but a herd of giraffes in the forest, with the light passing through in different ways, the sun spots here and there and the tall necks of the giraffes, it is impossible to see them; and Cummings says time and time again he has had a herd of giraffe browsing in the edge of a forest pointed out to him by his native hunters, and even with the aid of a telescope he could not see them himself. At yet other times he has taken the blasted tree trunks for the necks and bodies of giraffes; but found his mistake on closer approach.

The Bengal tiger, seeking its prey among the jungles, exactly harmonizes, in its upright bands of color, with the lights and shadows around it.

The leopard in the forest, resting upon the trunks and limbs of trees, with the play of lights and shadows from above, has in his own skin a very good imitation of the sun spots.

* Condensed from a lecture by Dr. Benjamin Sharp, at the Academy of Natural Sciences, Philadelphia.

Wild hogs are striped, and when threatened will squat among the leaves and become very inconspicuous.

The tawny color of the lion harmonizes with the barren wastes upon which it lives.

The bird known as the creeper, native among us, greatly resembles in color the bark of the trees.

The color of killdeers, both young birds and nests, closely resembles that of the stony ground on which they live.

The rabbit is very inconspicuous upon the ground at rest until he starts up and shows his white "cotton tail;" and this brings us to the recognition marks distributed among the gregarious animals, and to which Wallace has called the attention of naturalists.

Very characteristic recognition marks among the animals are those that are of such a nature as to keep the herd together. The peculiar white patch about the tail of a deer is one of these recognition marks. Hunters know that this can scarcely be seen if the animal is not frightened; but when, being shot at, it runs away, this is one of the most conspicuous features of the deer. The other members of the herd, seeing this recognition mark in the escaping animal, know the danger and take flight.

There is a peculiar white and very characteristic marking about the eye of one of the gazelles; and all these animals living in Africa and on our Western plains have more or less of these so-called recognition marks. The Rocky Mountain antelope has the recognition markings in the head.

We find birds also very well marked; for example, the white bands on the tail of the whippoorwill, which bands are not seen when the animal is not frightened or moving.

Mimicry was the first term used in these peculiar adaptations of color to surroundings. Originally the term mimicry meant a resemblance of the animal to its surroundings, be they animate or inanimate; but now we restrict "mimicry" to where one animal mimics another animal. This is very clearly shown in the humming bird moths, which have been repeatedly shot by the naturalist Wallace in mistake for humming birds. The humming bird moth is one of the sphinxes, in which the tongue, instead of being rolled up, is kept out straight, resembling the bill of the humming bird; while at the end of the abdomen a number of hairs run out and resemble, to a certain extent, the bird. The flight of the sphinx closely resembles that of the humming bird; and for two such naturalists as Bache and Wallace to be continually making these mistakes proves the resemblance and shows why a bird, feeding upon insects, would let a humming bird moth go, deeming it a humming bird.

In the East Indies, a cuckoo mimics a hawk in both size and color, so that one is often mistaken for the other.

The coral snake occurs in our Southern States and in Trinidad, being poisonous. There is a snake that mimics the coral snake that is perfectly harmless. Some of the people insist that all of the coral snakes are poisonous; others, who have had experience with the form mimicking the coral snakes, say they are not.

As to the leaf butterfly, in old books we read how bushes in India have flying leaves. The leaves would come off and fly around. Wallace in his work says: "In the East Indian archipelago we would see these butterflies alight upon a bush and thoroughly disappear." They simply resembled in form and color the leaves of the bush upon which they rested.

Caterpillar and cocoon found in this locality will resemble the bark of the trees upon which they rest. Doctor Skinner, entomologist of the Academy of Natural Sciences, relates how once finding one of these caterpillars and having at hand nothing to collect or carry insects, he went off a short time to get his materials, and on returning for this caterpillar, though he searched over an hour and though it probably had not moved over a half inch, it was so exactly like the bark of the tree he could not find it.

Not only does the caterpillar have this protective coloration, but also the cocoon, resembling the bark of the tree upon which it is spun. The butterfly, also, to a certain extent, is concealed in this way.

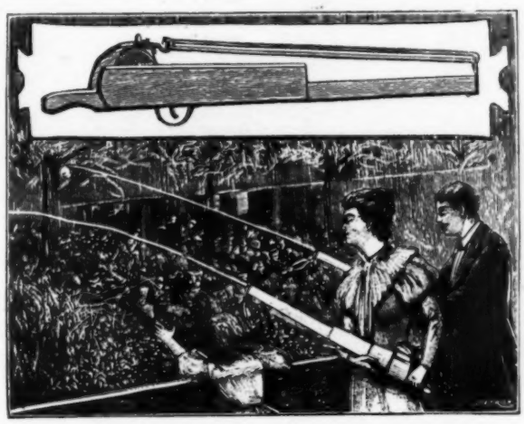
CONFETTI AND SERPENTINES.

DURING the Parisian carnival and midlent, confetti and serpentines have full sway. Although the invention is of recent date, it is making up for lost time. How many confetti and how many serpentines? According to the taste of some, there are altogether too many. Upon the boulevards and the large streets they form a continuous rain. In the evening, the confetti are found in layers of from half an inch to an inch and a half in thickness at certain points, and the serpentines are seen involving the trees in their multicolored meshes. In the sun the effect is charming, but the next day, if it happens to rain, the aspect is mournful.

The confetti having come into fashion, it follows as a necessary consequence that an endeavor has been made to derive as much advantage from them as possible. The spirit of invention is not wanting in Paris. People, getting tired of throwing them by the handful from the balconies of houses, have often, in order to expedite matters, emptied whole bagfuls of them upon the heads of the crowd. It is a very heavy circumscribed rain, but it does not last long enough. On the Boulevard de la Madeleine we have seen a dozen large bagfuls exhausted in this way in five minutes. This being wasteful, an endeavor was made to do better. Then the confetti cane made its appearance. This new air gun was a success, because the little disks are thrown to a distance and fall in a colored shower upon the floats and emblematic figures. It is impossible to escape the shot, for the weapon is accurate, and the projectiles, shot with force, fall gracefully upon the object selected as a target. At a distance of thirty feet one is as sure of covering his chance enemy as if he had fired an explosive shell. For the fetes of Nice and Cannes we shall evidently have some day a flower air gun, so that it will be possible to throw bouquets and perfumed petals to a distance. In the meanwhile, Parisians are firing confetti with the cane in fashion. This has the appearance of an ordinary bamboo walking stick. The silver head is unscrewed and the owner takes from his pocket a long cartridge loaded with a respectable number of colored confetti, which he introduces into the cane. With a rod he then rams home the cartridge, which causes a spring to bend. After this he tears and removes the paper covering. The weapon is now loaded. Toward the middle of the cane there is a trigger button. The "Queen of Queens" is passing. The button is pressed, the spring is freed and the entire supply of confetti is fired at once like a ball. A wheat sheaf jet forms at a distance of from 25 to 30 feet and descends like a colored rain upon the royal float, which becomes covered with emeralds and sapphires! There are persons who fire a hundred cartridges a day in this manner, much to the amusement of idlers. The confetti cane has proved a success.

In another form the same system has found its way into restaurants, to the family table, and especially into private rooms. A party has dined well and every one is merry; it is time for the champagne. The glasses await the bottle with its golden neck. The wire is cut, the cork starts and the foam is about to appear, when, to the surprise of all, a bouquet of confetti, instead, escapes with noise from the bottle, strikes the ceiling, falls back upon the table and covers it with petals of every hue. This is "champagne aux confetti." The stratagem may be imagined. As with the cane, the bottle has been loaded with a cartridge, and, through pressure upon a well concealed spring, the cork and confetti have been started.

Finally, in order to exhaust the list of novelties in this line, it would be unjust not to mention the "Spirobolus," a sort of serpentine shooting crossbow. This is an out of door apparatus that has its devotees. The serpentines thrown by hand do not go very far, and, in most cases, fail to hit the mark. The idea occurred to make the firing sure and to give it true precision. As if by magic, the spirobolus unwinds the roll of paper to its full extent in the twinkling of an eye. The effect of the unwinding of this colored paper band is very pretty. The system is simple. The roll is placed in a groove formed in the stock of the instrument, which is provided with a strong rubber cord that engages with a powerful spring. Upon a trigger being pulled the cord is freed, and the spring, in relaxing, sets the roll in motion. To this effect the roll is provided externally with a band of cloth which is attached to a fixed point, and which enters small points placed in the groove of the instrument. One of the ends of the serpentine is thus attached. The propulsion causes the unwinding of the roll, which continues paying out the paper until the other extremity is reached. It is unnecessary to say that firing with the spirobolus must not be done at close range, since some one might be hit and harmed by the roll before it was entirely unwound. —La Nature.



SPIROBOLUS FOR FIRING SERPENTINES.

CANE FOR FIRING CONFETTI.
1. Cartridge. 2. Ramrod.

CONFETTI FIRED FROM A CHAMPAGNE BOTTLE.

THE CULTIVATION OF CHICLE, FOR CHEWING GUM, IN MEXICO.

CHICLE chewing gum is principally extracted from the chico-zapote, the chic-zaptl of the Tarascans, says the Journal of the Society of Arts. Other plants are also chicle producing, such as Amate, growing wild in the district of Jalapa, Tabasco; Caimito, cultivated and found wild in the district of Jalapa, in the municipalities of Cunduacan and Cardenas, Tabasco, and in the canton of Jalapa, Vera Cruz; Cajou de mico, found wild in the municipality of Macuspana, Tabasco, and in the department of Comitan, Chiapas; Copo, found wild in the municipality of Frontera, Tabasco; Ghichixisha and Matapalo, found wild in the municipality of Zanatepec, Oaxaca; and Sictillo or Yoyote, indigenous to the districts of Cunduacan, Yacajuca, and Huimanguillo, Tabasco.

Sir Henry Dering, H. M. Minister at Mexico, in a further report upon the vegetable products of Mexico, says that chico-zapote (Acheas sapota of Linnæus) is the most abundant and important of the gum producing trees. This tree is found in many districts, and it is cultivated in the districts of Choapam, Cincatlan and in the municipality of Zanatepec, Oaxaca; in the districts of San Juan Bantista, Jalapa, Cunduacan, Cardenas, Nacayuca, and Huimanquillo, Tabasco; in the districts of Jalapa Cordoba, Minatillan, Vera Cruz, and in parts of Morelos and Michoacan.

Chico-zapote belongs to the family of Sapotaceæ, and two kinds, the red and white, have been found in the dense forests of the above mentioned regions. The white zapote produces more gum than the red kind—as high as 6 pounds to the tree—and the white is generally taller, being 12 meters in height, while the red zapote has a thicker bark, from 8 to 10 meters high and seldom yields more than 3 to 4 pounds of chicle. The leaves of both trees are somewhat elliptical, and on young branches or shoots they are rather numerous. The fruit is spherical, sometimes 2 and 3 inches long; its edible matter is white, and tastes like the pear, and the seeds are two or three in number, of a dark brown color, flat, and irregular in shape.

A warm, moist climate is necessary for the successful growth of the tree if large amounts of fluid are expected. Higher than latitude 22° N. it will not grow at all, and north of Vera Cruz city it will not do well in the mountains above 2,000 feet. However south of 19° N. latitude it is cultivated at altitudes as high as 3,500 and 4,000 feet above sea level, yet it will thrive best at elevations between 150 and 1,200 feet even in these latter regions.

The best soil adapted for its cultivation is that occurring in valleys and undulating lands along the river meadows at the foot of the mountains. In the Tuxpam and Papantla valleys, especially in the dales adjoining the Pantapec, Cazones (San Marcos), and Tecoluta Rivers, splendid lands suitable for its cultivation can be found.

The zapote can be propagated from cuttings, suckers and layering, but the tree grows readily from the seed, and that system has been adopted by those who plant it. Nursery beds are prepared in the usual manner in a half shaded space close to a stream. The seeds are sown in October and November, and sometimes in July. When the seedlings are 18 to 24 inches high, they must be transplanted.

As the tree is a hardy one, the expenses of keeping the zapote plantation clean are small. One or two light weedings a year is all that is necessary. At the fourth or fifth year after transplanting the tree may be tapped, but it is best to wait until the sixth or seventh year, or when they are 12 to 15 inches in diameter, wherein better results may be obtained. The tree lasts over 100 years, and then, or before, its fine wood can be utilized for the manufacture of first class furniture, or for durable timber. The gum is produced from the leaves, fruit, and bark of the tree. From the fruit it is extracted in the months of March and April, before the fruit becomes ripe. When gathering the fruit, the stem is allowed to remain on it, but subsequently taken off to admit of the juice running out. This is collected in a shallow vessel, allowed to solidify, washed in warm water to collect and clean it, and then boiled down to evaporate the water, set aside to cool, and lastly formed into blocks to be marketed. Three thousand two hundered zapote pears produce one pound of gum.

The fruit is also sold for about a cent apiece in Vera Cruz, Puebla, Oaxaca, Orizaba, Mexico, Guadalajara, and other large cities, and has recently been exported to the United States. In September and October the gum is extracted from the leaves. The process is the

same as that of the fruit, and the yield alike. After the rainy season is over, generally in October, the trees are tapped once every year.

The custom of the natives, the chicleros, is to get up the tree, to a distance of about 46 feet, make three diagonal cuts by a double oblique blow of the machete on either side of the tree, and have the wounds join at their lower ends. A shallow tin vessel is tied on to the tree below the wounds to collect the juice. Then the operator leaves this tree and taps another. He performs this operation in twenty minutes, and it takes three-quarters of an hour for the tree to bleed itself. One man will tap from twelve to sixteen trees per day, each producing from 3 to 6 pounds of juice. This is collected in gourds holding 12 pints, and heated in an iron pot until it boils up, when it is stirred with a stick quickly and continually until the foaming gum subsides, and has been reduced to half. When cool it is washed in water and formed into blocks, marquetas, of 2, 4, 6 and 12½ pounds.

Sir H. Dering says that the present system of tapping could be improved, and that the juice should be strained before being boiled down. The expense of a plantation of 100 acres to the time of production (six years after transplanting) is as follows: Clearing the land, from $600 to $800; nursery, $250; planting, $600; weeding six years, $1,200, and fencing, $50. At an additional expense of 10 per cent, a patch of Indian corn can be raised, and the proceeds from it will more than meet the expense of the plantation.

In the Tuxpam valley it costs from $5 to $7 per arroba of 25 pounds to gather and clear the gum—that is, by contracting the work with the experts (the chicleros); but by hired labor there and in Papantla, Misantla, Esperiol and Zamovra Gutierrez the cost will only be from 10 cents to 15 cents per pound. In Campeche and Michoacan the cost is as high as 20 cents per pound and in parts of Oaxaca, Vera Cruz, and Tabasco, from 4 to 25 cents a year per tree is paid for the privilege of tapping trees on private lands. The production of chicle for the year 1892, the latest for which the particulars are available, was as follows: In the district of Carmen, Campeche, 1,380,740 kilogrammes, valued at $12,000; in Oaxaca the districts of Juquila and Tuxtepec reported 1,150 kilogrammes each, valued at $950; in Puebla, the district of Huauchinanys produced 1,200 kilogrammes, valued at $600; in Tabasco, the district of Balancan yielded 16,108 kilogrammes, valued at $11,200; and the municipalities of Zamora, Gutierrez and Tecolutu, Vera Cruz, reported 3,445,434 kilogrammes, valued at $1,824,000. Sir Henry Dering says that the price of chicle gum at New York City was, at the date of his report (July 18 last), 45 cents gold per pound.

THE POPULATION OF RUSSIA.

THE results of the first one-day census, which was made throughout the width and breadth of the Russian empire on February 9 last, were expected with great interest, says Nature. The last census was made in 1851, and a partial one in 1858, and yet it was not a census proper, for the local police authorities on the spot merely made lists of the permanent residents and taxpayers in each locality. After much preparatory work, it was decided to make, this year, a "one-day census;" that is, in the lists which had to be made for each house in each locality, all those persons who spent the night in a given house and in a given locality on February 9 (or about that date in the villages), had to be mentioned, whether they were permanent residents or not. It was quite a novel experiment, which was looked at with little confidence; but the vice-president of the Russian Geographical Society, who had had already a great deal of experience with such censuses as they were made, since 1870, in separate big towns (in these censuses the illiterate population filled their lists, as a rule, admirably well), insisted upon the new method being accepted. The census was organized under his guidance, and seems, so far as can be judged, to have been quite successful. The items, obtained from all the local committees, partly by telegraph—with the exception of some parts of the province of Yakutsk—are now published; and the population of the empire appears from them as follows: European Russia, 94,188,760; Kingdom of Poland, 9,442,690; Grand Duchy of Finland (Finnish yearly census), 2,527,801; Caucasia, 9,723,553; Siberia and Sakhalin, 5,731,732; the Kirghiz Steppes, 3,415,174; Turkestan, with the Transcaspian region and the Pamirs, 4,175,101; Russian subjects in Bokhara and Khiva, 6,412; total, 129,211,113. The corresponding figures, in 1851, were: European Russia, 52,797,685; Poland, 4,852,055; Finland, 1,636,915; Caucasia, 4,436,152; Siberia, 2,437,184; Steppes, 1,220,654; total, 67,380,645. It may thus be said that, although the percentage of births is very high in Russia, it took nearly fifty years for the population to double.

An English writer about Russia made, some time ago, the remark that Russia suffers from apolism, that is, from a want of towns. This want has lately very much disappeared. There are now in the empire no less than 19 towns having a population of more than 100,000 (out of which two in Poland, two in Caucasia, and one, Tashkend, in Turkestan); 35 towns with populations from 50,000 to 100,000, and 69 towns with populations of from 25,000 to 50,000. St. Petersburg has already attained the figure of 1,267,023, and Moscow approaches the million (988,610).

It is worth mentioning that no less than 230,000 persons took part in the census; very many of them were volunteers, who were recruited among the students of the universities and the high schools.

A Roentgen society has been formed, with Prof. S. P. Thompson as the president, says Nature. The intention of the founders is that the society shall occupy a position between those devoted purely to medicine, to physics, or to photography. Some of the members will study the sources of the Roentgen rays, others the applications; some the induction coils, others the tubes and the various forms and adaptations of the apparatus used in the production of the rays. Roentgen photography has been found serviceable in so many branches of scientific investigation that the society appeals to a large constituency for support. It should be the means of increasing the efficiency and applications of the rays, and should also be of assistance to surgeons and others who have entered the new field of work without previous training in physics.

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